COMPUTERS AS AN ENVIRONMENT FOR FACILITATING SOCIAL INTERACTION IN CHILDREN WITH AUTISTIC SPECTRUM DISORDERS

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Abstract of thesis

Autism is a developmental condition that affects communication, imagination and social interaction. Of these three impairments, it is the last which has the greatest negative impact on the life of children with autism and their families. Different intervention programs have attempted to address social interaction difficulties but there is clearly a need for a school-based program that helps develop social interaction and promote social skills within educationally 'natural' settings.

Teachers, parents and researchers widely believe that children with autism enjoy using computers and in most western countries, most children with autism have access to them at home or at school. Drawing from communication theory, this thesis explores the hypothesis that computers can provide a motivating, real-life environment in which social interaction in children with autism can be facilitated.

In a series of staged studies, the ways in which computers might be used to facilitate social interaction are investigated. The first phase established the level of access to computers that children with autism typically now have and how educators currently use computers with this group of children. The experience of those working in non-school based programmes aimed at developing social interaction in children with autism was also explored. It was also necessary to explore any inherent constraints on the development of software specifically aimed at children with autism.

Having established available resources and constraints, the thesis then explored the social behaviours of children with autism within a computer-based environment, using play-based activities. In a number of interlinking studies, differences and similarities in social interactions were explored when i) working on a paper-based versus computer-based version of the same two player game, ii) playing the same game at the computer, either against a partner or alone, and iii) working with a partner on a series of graded, computer-based jigsaw puzzles, with the partner acting either as a collaborator or competitor.

The findings presented illustrate the potential for eliciting increased social interaction in children with autism when working alongside other with computers, and suggest the possibility that time spent with computers by children with autism may help them to gravitate from a solitary activity towards a social one. The relevance of the findings of these studies to practice are discussed and the need for further studies highlighted.

Declaration

This thesis has been composed by me and is entirely my own work.

Begoña Pino

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ASD	Autistic Spectrum Disorders
NAS	National Autistic Society
TEACCH	Treatment and Education of Autistic and Related Communication-Handicapped Children
SPELL	Structure, Positive, Empathy, Low arousal, Links

Chapter 1: Autism

> "*Autism is an interaction disorder, everything else is a consequence*" (Kaufman, 2004).

The aim of this thesis was to explore how computers might facilitate social interaction in children with autistic spectrum disorders (ASD). The impairment in social interaction associated with autism clearly has a very detrimental effect on the life of children with autism and their families and indeed for some researchers it is considered to be the core feature of the condition:

"*Autism is an interaction disorder, everything else is a consequence*" (Kaufman, 2004).

Over the years, various intervention programs have been used in an attempt to ameliorate the children's social interaction difficulties. A great many of these are home-based, but there is clearly a need for a school-based program which has the aim of developing social interaction and promoting social skills within educationally 'natural' settings. Teachers, parents and researchers widely believe that children with autism enjoy using computers, and in most western countries, most children with autism have access to them both at home and/or at school. Drawing evidence from the communication theory, this thesis explores the hypothesis that computers can provide a motivating, real-life environment in which social interaction of children with autism can be facilitated.

In order to design a school-based program that could make use of computers, it was necessary first of all to establish the level of access to computers that children with autism typically have at present, and to explore the ways in which educators are currently using computers with this group of children. Secondly, there was a need to explore any inherent constraints on the development of software specifically aimed at children with autism.

Having established available resources and constraints, the thesis goes on to explore the social behaviours of children with autism within a computer-based environment, using play-based activities. Despite the increasing number of studies using computers with children with ASD, few have focused on their potential for promoting social interaction through play. Before addressing the potential effect that computer use might have on children with autism, however, it was first necessary to review the relevant literature on autism and to address some of the main issues of computer use as it might relate to autism in order to understand how children with autism might eventually benefit from the use of computers as mediators of social interactions.

Part I: Autism

1.1 Introduction to Autism

Autism is a lifelong developmental condition that isolates the individual from the world. It manifests itself in a number of ways, such as difficulties in understanding other people and coping with social situations, difficulties in developing verbal and non-verbal communication, and a deficit in imagination, which is replaced by repetitive behaviour and resistance to change. These difficulties in social interaction, social communication and imagination are known as the 'triad of impairments', as defined by Lorna Wing (1996).

Autism was first described by Leo Kanner in 1943, and Hans Asperger in 1944. These researchers used the same label to name a very similar condition although working independently. Kanner observed 11 children who displayed autistic aloneness and desire for sameness and yet showed islets of ability; in some of these cases, there was a variety of additional problems. Asperger´s description focused on the difficulties with social integration but also noted originality in thinking, together with lack of eye contact, unusual speech melody, and stereotypic movements (Frith, 2003). The distinctive feature for the two conditions described by these two authors was cognitive capacity, with Kanner's group suffering from learning disabilities, and Asperger's group being of average or high ability (National Autistic Society, 2005).

1.1.1 Diagnosis

It is usually the parents who first notice there is something wrong with their child, who may have been developing normally but has started to become less and less responsive, or may not be developing language in the same way or at the same rate as other children of the same age. Depending on age, signs causing concern might include a resistance to being cuddled, avoidance of eye contact, a preference to play alone, an apparent difficulty in understanding speech, abnormal speech (in tone, pitch, or rhythm, or echoing what the other person has said), lack of fantasy games or role playing, development of compulsive routines and obsessive interests, repetitive behaviours (i.e.: flicking fingers), self injury behaviours, and/or hyperactivity, amongst others (McKesson, 2005).

Autistic spectrum disorders (ASD) is an umbrella term that includes autism, Asperger's Syndrome, pervasive developmental disorder (PDD), and PDD-NOS (not otherwise specified). Sometimes those with autism are also labelled as high functioning or low functioning. High functioning children with autism have a normal IQ, and although they still have social and communicative impairments they may be able to cope with academic demands, whereas low functioning children have below average IQ which makes learning more difficult for them, including the acquisition of many basic communicative skills.

Despite the influence of genetic factors, a definitive biological marker of autism has not yet been identified; psychological tests may not spot some cases, and specialists need to rely on behavioural check lists, making it difficult to diagnose. The most widely used check lists are the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), which looks at impairments in social interaction, communication and imagination (discussed in the next sections), and the International Classification of Diseases (ICD) (Frith, 2003).

What makes ASD difficult to diagnose is the great variation in individual cases. Some features of the diagnostic criteria might be clearly present, indeed in an extreme fashion, but also they can also manifest themselves in such a subtle way that it is sometimes very difficult to diagnose autism with any great certainty. In addition, learning difficulties may hide or be instrumental in causing certain behaviours to arise. Factors such as environment or education change over time and individuality may influence additionally the autistic behaviours displayed (Wing, 1996).

In order to identify autistic disorders, the DSM-IV (DSM, 1994) requires that two out of four criteria in qualitative impairment in *social interaction* be met; at least one criterion in qualitative impairment in *communication* is fulfilled; and one in restrictive, repetitive and stereotypical behaviours evidenced (this last area is described below under the heading "Impairment in *imagination*"). Both the DSM-IV and the ICD have been critisised for using artificially oversimplified criteria (Trevarthen et al., 1998), for ignoring other features of the condition (see section 1.1.5) and for the restrictive definition of Asperger's Syndrome: the criteria for Asperger's Syndrome diagnosis in both manuals include the criteria for 'autistic disorders', but in the absence of any associated significant language delays, or any cognitive and adaptive behavioural delays (Howlin, 1998; Mesibov, 2000). In contrast, Wing (1981), Gillberg (1989) and Tantam (1988, cited by Trevarthen et al., 1998) consider that both language and cognition may present with some delay in those with Asperger's, and these two opposed views have caused some controversy.

For some authors (Mesibov, 2000; Frith, 2004) the diagnostic issue of distinguishing Asperger's Syndrome and autism has an historical origin, based on the different descriptions of Kanner and Asperger: while Kanner gave a clear diagnostic description of the children he worked with, Asperger described several characteristics, such as pedantic language, eccentric interaction, narrow interests or motor clumsiness (among others) but did not define the features essential to making a diagnosis, and this has contributed to the confusion.

The prevailing view, based on genetic, neurophysiological, cognitive and behavioural information is that Asperger's Syndrome is a variation of the autistic spectrum (Frith, 2004; Trevarthen et al., 1998; Attwood, 1998a), even though it seems that the process of development is affected to differing degrees at different stages (Trevarthen et al., 1998). On the other hand, some experts (Rinehart et al., 2002) think that these disorders may turn out to be separate, both clinically and neurobiologically. Even if it is part of the spectrum, Frith (2004) considers it may be useful to maintain a separate label for the same practical reasons Wing had when she used it, both to raise awareness and to facilitate an appropriate educational placement.

All of the above increases the likelihood of professionals making very different diagnoses depending on which diagnostic handbook or criteria they are using, or on whether they are focusing more on one aspect (e.g. language delay), or another (e.g.: motor clumsiness) (Mesibov, 2000). What is very clear is that there is a need for a more detailed categorisation of conditions within the Autistic Spectrum, with the description of specific phenotypes (Frith, 2004).

However, for those who are working with individuals within the spectrum, these issues seem somehow irrelevant and having any kind of diagnosis (i.e. label) is considered useful by the majority of the professionals consulted during the research described here (specialists in psychology and education), on the basis that they think it gives access to resources from the educational and health authorities, for example – a view shared by Wing (1981). Since they are trying to meet the child's specific needs in a variety of domains (including social, communicative and imaginative), however, it is still useful to follow the descriptions given by the check lists when illustrating the main features of ASD.

1.1.2 Impairment in social interaction

According to DSM-IV (1994), behaviours which indicate impaired social interaction might be:

- difficulty with using non-verbal behaviours such as eye contact, facial expression, posture and gesture.
- lack of appropriate peer relationships.
- lack of spontaneous sharing of activities or interests with others.
- lack of social or emotional response.

Sicile-Kira (2003) added to the above list of criteria the lack of imitation, a preference to be alone, the use of adults as a mean to obtain something, and the lack of attempts to seek cuddles as a baby as possible indicators of an autistic syndrome being present. However, the best description was given by Wing (1996), who identified four types of autistic children with different patterns of social interaction:

- *The aloof group*: who choose not to react to others - ignoring speech and non-verbal communication, are indifferent to other's emotions, inexpressive, and use others in order to obtain something without interacting.
- *The passive group*: who accept social approaches although not initiating them, and who make eye contact on request.
- *The 'active but odd' group*: who display a degree of approachability to other people, usually adults, but with a focus on only their own interest, while making improper use of eye contact and demonstrations of affection.
- *The 'over-formal', stilted group*: who demonstrate a lack of any real understanding of social rules and applying them inadequately, for example being extremely polite within the family environment (this is the most common behaviour of more able individuals, from adolescence and onwards).

1.1.3 Impairment in communication

In the DSM-IV (1994), qualitative impairments in communication may be the following:

- delay or lack of spoken language or an alternative form of communication.
- difficulty in initiating or maintaining a conversation with others.
- stereotyped, repetitive or idiosyncratic use of language.
- lack of, or limited, spontaneous make-believe play and imitation (at appropriate developmental level).

Developing and then losing speech, speaking only of narrow topics or having difficulty in talking about abstract concepts were also mentioned by Sicile-Kira (2003). In contrast, Wing (1996) focused on four aspects of language use:

- *Use of speech*: One child in every four or five children with ASD may never develop speech, while the rest of them typically show clear delays in this area. When they first start speaking, they may show a tendency to repeat the last words they have heard from someone talking; echolalia is also a frequent phenomenon. After this initial stage of at least some kind of linguistic behaviour, some may develop more spontaneous speech, but at the same time make frequent grammatical mistakes. Even those who develop good vocabulary and grammar may have difficulty with the content of their speech (e.g. limiting it to a very small range of topics).

- *Understanding of speech*: the majority will eventually understand at least simple instructions. For those who are more able, their understanding tends to be quite literal, making for instance the comprehension of jokes difficult.
- *Intonation and voice control*: Odd intonation, with monotonous or inappropriate inflexion, is very common, along with difficulties in controlling the volume of their speech.

Using and understanding non-verbal communication: children with ASD tend to find it very difficult to understand and use non-verbal communication, with their non-verbal behaviour being limited to grabbing or pulling someone in order to obtain an object or to making simple gestures as nodding.

1.1.4 Impairment in imagination

The third set of criteria in DSM-IV (1994) focuses on "restricted, repetitive, and stereotyped patterns of behavior, interests, and activities":

- abnormal interests, because of their intensity or focus
- inflexibility, adherence to routines, rituals
- repetitive and stereotypical movement
- great interest in constituent parts of objects.

Wing (1996) supported the notion that these stereotyped behaviours might be the other side of the coin of a lack of imagination. Children with ASD, for instance, do not develop pretend play as typically developing children do, and tend not to join in other children's imaginative play. In addition, they have difficulties using "past and present experiences to plan for the future" (Wing, 1996, p.45).

1.1.5 Other features

There are a number of other characteristic features of autism which, while not considered as diagnostic criteria, appear in some children with ASD with relatively high frequency (Wing, 1996).

In relation to *movements*, apart from stereotyped movements (flapping, rocking, etc.), some children walk on tiptoe and some of them are very agile; others may be clumsy, while others tend to show abnormal gait and posture. Poor motor coordination might cause some children chewing difficulties and others difficulties in engaging with team sports; the latter require not only physical skills, but also knowledge of the rules. In the area of *sensory stimulation*, some children might be oversensitive to sounds, light, smells and touch, whereas others may not react at all, or be indifferent, even to pain (Wing, 1996).

Wing (1996) also mentioned the high *anxiety* levels some people with ASD experience, and how their *attention* span seems to be directly related to *motivation* for the activity in question. Anxiety, over-stimulation, and being surrounded by people whose speech is not understood, may cause additional problematic behaviours as the child tries to cope with them.

Finally, one out of ten individuals with ASD might excel in a particular skill, although it is more common to find individuals with exceptional abilities in visual-spatial activities (e.g. completing jigsaw puzzles) than in verbal ones.

1.1.6 Associated conditions

Views on the etiology of autism have changed over time and have included both neurological and psychological explanations (see section 1.1.9, p.10). The fact that a number of syndromes co-occur more frequently with autism than with other syndromes or in the general population - including hypomelanosis of Ito (a neuro-ectodermal syndrome), Moebious syndrome (a neurological disorder), Tourette's syndrome (neurological and genetically linked disorder), and genetic conditions such as Cornelia de Lange syndrome, Fragile X, or neuro-fibromatosis, among others (Howlin, 1998) - seems to support the neurobiological basis for the development of autism according to Gillberg and Coleman (1992 - see also section 1.1.9), although this does not of course rule out the possibility of psychological factors also influencing behaviours and developmental outcomes (see section 1.1.9).

Learning difficulties

Learning difficulties appear in nearly one third of the population with autism (including Asperger Syndrome), and with a greater degree of severity in the cases of autism as described by Kanner, in particular. It is important to take into consideration the fact that learning difficulties do not have an explanatory nature as far as autism is concerned, for the association between these two conditions is not yet clear (Wing, 1996).

Epilepsy

According to Wing (1996), more than a quarter of the children who have learning difficulties might have at least one epileptic fit by the time they become adults. This could occur at any point in their lives:

sometimes only after a fever, or as a one-off incident, or continuing over a period of time. Gillberg and Coleman (1992) affirmed that the association between autism and epilepsy was unquestionable, and suggested a brain dysfunction being present, and of a specific nature rather than simply as a more general form of developmental delay. They also suggested that epilepsy might be present in a higher proportion (35-45%) of people with autistic-like conditions than in classical forms of autism (15-30%).

Rett's Syndrome

Rett´s syndrome affects only girls. It is characterized by an early onset, with the child gradually losing the ability to manipulate objects with their hands, developing walking difficulties and severe learning difficulties, and failing to develop in both the areas of language and pretend play. Although children with Rett's syndroome appear socially isolated, they seem to become more responsive over time (Wing, 1996).

Fragile X syndrome

This syndrome is caused by an abnormality of the X chromosome, and affects more males than females. Individuals with fragile X syndrome have physical manifestations of the syndrome i.e large ears and long face, while they often also exhibit learning difficulties, motor stereotypies, oversensitivity to sound and touch, hyperactivity and attention difficulties. Wing (1996) suggested that their avoidance of eye contact and interaction might be more a consequence of shyness, anxiety and oversensitivity than of indifference.

Landau-Kleffner syndrome

This rare disorder appears in children between three and seven years of age, who start displaying autistic like behaviours such as poor eye contact, repetitive behaviour and difficulties with any change in their routines; some also have fits. Treatments include steroid drugs, anti-epileptic drugs and brain surgery.

Williams syndrome

This syndrome is characterized by repetitive speech and inappropriate social approaches.

Tourette's syndrome

This syndrome manifests itself in a variety of behaviours that include attention deficit, grunting, twitching, obsessions, over -activity and also inappropriate utterances (often obscenities).

Cornelia de Lange syndrome

The main feature of this syndrome is self-injurious behaviour.

Other autistic-like conditions

There are several medical conditions associated with autistic-like behaviours such as tuberosclerosis, chromosome abnormalities, neurofibromatosis, phenylketonuria, and rubella embryopathy, among others. Hearing and visual impairments co-occur frequently, but deafness and blindness are rare (Gillberg and Coleman, 1992).

It is also usual to find language difficulties among children with ASD. They vary from developmental language disorders, including difficulties understanding words or producing them, to a semantic-pragmatic disorder, where the individual understands what is being said but does not understand the meaning of it. In addition, disorders of attention, motor co-ordination and perception can occur singly and/or in combination (Wing, 1996).

1.1.7 Prevalence

The first epidemiological study of autism was conducted by Victor Lotter in 1966 by screening all the children aged between eight and 10 from Middlesex County. He found a prevalence of 4.5 per 10.000, with a ratio of 2.5 boys to 1 girl, using criteria of social aloofness and elaborate rituals and routines, which might not have been sufficient to ensure identification of autism as such (Frith, 2003). Since then, several other studies that have taken place have showed an increase in prevalence. Wing and Gould (1979) looked at all children with an IQ level below 70 within an area in London and found a prevalence of 20 per 10,000. In Gothenburgh, Ehlers and Gillberg (1993) studied children with an IQ of 70 or above and found a prevalence of 35 per 10,000, which would have reached 71 per 10,000 if those with social impairments had also been included. Wing and Potter (1999) combined both studies to produce a prevalence of autistic spectrum disorders of 91 per 10,000 (see Table 1.1, over). The latest prevalence study, by Wing and Potter (2002), reported 8-30 per 10,000 for cases of classical autism, and up to 60 per 10,000 for prevalence of autistic spectrum disorders in total. This contrasts with Kadesjö et al. (1999) who found a prevalence of ASD of 1.21% over all levels of IQ in children aged seven in a Swedish town.

Recent figures have given the impression of a higher incidence than in the past, creating fears of a possible epidemic. Although there is still some controversy, it is generally thought increased prevalence rates are the result of a wider set of diagnostic criteria being used, along with an increased awareness of the condition. On the other hand, the increased rate in males as compared to female, with approximately 4:1 in autism and 15:1 in Asperger's syndrome, is a consistent finding in recent studies. The reason for this difference is not clear, but there is the possibility that girls in the higher functioning range are compensating better than boys and remain undetected (Frith 2003).

Table 1.1 Estimated prevalence rates of autistic spectrum disorders in the UK. National Autistic Society (2004)		
People with Learning Disabilities (IQ under 70)		Approximate Rates per 10,000
Kanner syndrome		5
Other spectrum disorders		15
	Total	20
People with average or high ability (IQ 70 or above)		
Asperger syndrome		36
Other spectrum disorders		35
	Total	71
Possible total prevalence rate of all autistic spectrum disorders		91

1.1.8 Onset

Autism is present from birth, but since there is no biological marker, it is usually not until the child is around two or three years of age that some problems begin to become apparent. Parents usually report that their child was developing normally until they realised that something was wrong. Children suddenly start losing skills they had mastered, or develop language very slowly, or evidence difficulties in coping with change. Although some children are diagnosed as early as 18 months old, the onset is not typically diagnosed until after three years of age (Wing, 1996).

1.1.9 Causes

It is generally accepted that autism is a neuro-developmental disorder (Trevarthen et al. 1998). There is no clear identifiable cause as yet, just the hypothesis that some as yet unknown factor is causing a variation in the normal development of the brain at a particularly critical time. Research in cases of identical twins has found a high level of concordance with respect to autistic spectrum disorder, although it is not so strong in the case of classic autism. Why autism affects identical twins differently is not known, and some environmental factors have been considered. These differences suggest that there is not only a genetic component but a range of components which could in turn be related to a continuum of difficulties, reinforcing the concept of autism as a spectrum (Frith, 2003).

Serotonin levels have been found to be higher than average in a subgroup of people with autism. Parents and professionals have reported on a significant number of cases where children with ASD have also had biochemical and immunological problems whose origin might be mercury toxicity, yeast problems, casein and gluten intolerance or viral infections. Children with ASD also appear to have difficulties disposing of environmental toxins (Trevarthen et al., 1998; Sicile-Kira, 2003).

It is more likely that autism is caused by a genetic predisposition triggered by a combination of environmental factors, with this equation determining the final developmental outcome for the individual. This explanation differs from an earlier one suggesting that inappropriate parenting was to blame, i.e cold, distant parents who would push the child into isolation (Sicile-Kira, 2003). Bruno Bettelheim (1967) suggested that emotionally cold parenting was one of the origins of autism, with unresponsive behaviour of the parents towards the child eroding any motivation for social interaction in the child.

A recent study carried out by Fraga and Esteller (2005, as reviewed by Weiss, 2005) looked at the differences in the genetic profile of 40 pairs of identical twins. The results showed that environmental differences can activate or deactivate the genes that protect against or increase the chances of suffering a particular condition such as cancer, diabetes or heart disease. The differences were smaller among younger twins that lived under the same conditions, which indicates that lifestyle or specific events have a role to play, although small events before birth might account for minor differences in appearance or personality. This might explain the case of twin children with differing levels of ASD, but the study focused on conditions that appear later in life, whereas autism can be identified at 2 years of age. This suggests that critical events are happening very early on, probably before birth.

But genetics is not the only area contributing to the knowledge base of autism. Numerous neuropsychological studies have found increased brain volume and problems in several regions of the brain: in the cerebellum, medial temporal lobe, frontal lobe (prefrontal cortex) and corpus callosum (Trevarthen et al. 1998). Hashimoto et al. (1995) found that in autistic patients, the cerebellum was reduced in size compared to normal individuals, some researchers have observed smaller vermal lobules VI-VII in autistic people (Courchesne et al. 1988), and there is also evidence of significantly reduced size in some areas of the corpus callosum, which is involved in the transfer of information between brain hemispheres (Piven et al. 1997).

The cerebellum coordinates functions that influence attention, balance and proprioception. The medial temporal lobe, including the amygdala, hippocampus and entorhinal cortex, are involved in the development of face recognition, recognition of the affective significance of stimuli, perception of body movement and cross-modal association, thus, when impaired, may therefore affect the development of motor imitation, or joint attention (Dawson et al. 1998). Thus, for the researchers involved, these key problems in brain development are seen as being directly linked to the specific developmental problems typical of autism, since they affect functions central to the development of higher level mental processes.

The above are illustrative examples of the growing body of evidence that seems to strengthen the claim for a neurobiological basis for autism. On the other hand, research has shown that other elements, such as neurochemical pathways or genetic factors, may be playing a role. Further research is clearly needed in order to identify the factors underlying autism, the ways in which it is manifested, and the developmental stages by which it unfolds.

Psychological theories

Discovering the underpinnings of autism and understanding the condition are inter-related. Several theories have been proposed to account for different aspects of autism and to provide possible explanations of the processes underlying the behavioural and communicative disorders that characterise this condition.

One of the best-known theories is that proposed by Baron-Cohen, Leslie and Frith (1985) in an attempt to explain the difficulties that people with autism have in social interaction. They suggested that the inability to understand the mental state of others - what they called 'having a theory of mind'- is central to the problems experienced in social interaction, since this means that individuals with autism can neither understand nor predict the behaviour of others.

The experimental paradigm used by Baron-Cohen et al. has become a classic one in autism research. They presented children with two dolls, Sally and Ann. The experimenter informed the children that Sally had a marble in a basket and once she left the room, Ann took the marble and hid it in a box, before Sally had returned. Then, the experimenter asked each child individually where would Sally look for the marble. More than 80% of typically developing children - and also children with Down's syndrome of an equivalent developmental age - were able to give the right answer (in the original basket) whereas 80% of the children with autism failed the test (believing that Sally would know the changed location, even although she had not witnessed the event).

Building on this research, Baron-Cohen (1995) asserted that humans mind-read automatically. This allows us to interpret and predict the behaviour of others, and thus to engage successfully in social interaction and communicative processes. Essential skills involved in mind-reading are decoding gazes and understanding the mental states (thoughts, feelings, intentions) of others. Baron-Cohen suggested that an impairment in these skills causes children with autism to suffer from 'mind-blindness'.

Some researchers (Trevarthen et al., 1998; Wing, 1996) criticised the methods used to test the theory of mind because they rely on verbal skills, which makes it difficult for people at the lower end of cognitive abilities to grasp the problem. Trevarthen et al. (1998), however, supported the view that the root of difficulties in mentalising is an impairment in inter-subjective functioning, which means that those with autism cannot access someone's state of mind on the basis of their affective-expressive behaviour. Whilst newborns depend on affectionate responses from their carers, those with autism cannot distinguish the actions of others from their own. By the age of nine months, these differences become obvious in deficits in behaviours such as joint awareness, self-presentation and cooperative task performance.

In the same vein, Hobson (1990a) stressed that children go through a process of acquiring a concept of self, finding relatedness with others and then developing relationships with others. They do this by relating their subjective experiences to the other's bodily expressions. In the case of children with autism, he suggested that their difficulties in forming representations for the perception and expression of emotions may underlie their problems with affective interpersonal relations. This failure in socio-cognitive understanding, it is hypothesised, may predate any subsequent difficulties in developing more advanced levels of understanding, such as a theory of the minds of others (Hobson, 1990b).

After reviewing the literature, Happe (1994) concluded that the minority of children with autism who are able to pass the theory of mind tests did so by different means than intuitive social understanding. Ozonoff et al. (1991, in Happe, 1994) supported Happe's view that executive functioning was impaired in children with ASD, including those who had passed the mentalizing tests, causing them difficulties in problem-solving, e.g. difficulty in planning how to achieve a particular goal. The connection between both types of problems is not clear, however, nor is it known if there is a third phenomenon causing both to arise.

Frith (1989) attempted to construct a theory that could account for a series of features found in autism that were being ignored by other theories. Some of these features were restricted interests, need for sameness, islets of ability, savant abilities, very good rote memory and an interest in parts of objects (Happe, 1994). Frith explained that instead of inferring meaning from the context, or grasping the main points of a story, (evidencing 'central coherence'), people with autism tended to give details the same value, focusing on the parts rather than the whole. A typical example is the ability to solve jigsaw puzzles by the shape rather than the image, or being better in identifying faces upside down than typically developing peers. Research conducted by Briskman et al. (2001) with parents of children with ASD has also supported Happe's theory of weak central coherence, as well as pointing to a genetic basis for autism, finding frequent special interests, attention to detail, difficulties with change and need for routines among such adults (Frith, 2003).

More recently, Baron-Cohen (2002) has defined the term "systemising" to describe the intuitive understanding of how systems or mechanical things work. This is in contrast to empathising, which is an understanding of mental states and which makes use of the theory of mind. His team suggested that these two skills are part of a continuum at one extreme of which is autism, with excellent systemising and poor empathising; at the other extreme, is poor systemising and excellent empathising but this is not recognised as a condition, since poor systemising can often be side-stepped by using good social skills.

Frith (2003) has attempted to re-conceptualise autism by focusing on the strengths rather than the weaknesses within the autistic population. There is, for example, a striking 10% of those with autism who have a special talent related to a preference for information processing focused on detail (as reflected e.g. in high-level architectural drawings, precise calendrical calculations), the basis of the weak coherence theory. Another theory has proposed that difficulties in handling executive functions underlie the problems those with autism experience with changing situations and in top-down organisation of information processing, with this in turn having a direct effect on developing stereotypical behaviours and narrow interests.

Together with the theory of mind, each of the theories described above provide complementary accounts of autism, but there is no one unified theory that explains all of the behaviours characteristic of this population. However, Frith suggested that they all refer to high-level cognitive processes related to self-consciousness. For Frith, the connection between the weak coherence and executive function theories lies in the imbalance between weak top-down control and strong bottom-up information processing, which might be causing the malfunction that impedes mentalizing. Considering that mentalizing leads to an awareness of the self, a prerequisite for top-down control, as well as awareness of others, then the cause of autism appears to be a vicious circle where each difficulty is at the same time the cause and/or the consequence of the others and vice versa.

1.1.10 Therapies

Autism has a highly individual character in the sense that there is a variety of impairments in each case. Besides the triad of impairments, and sometimes as a consequence of these, there are other features that affect family life, such as restricted eating choices, an unusual sleep pattern, lack of toilet-training, aggression and/or self-injury behaviour (Howlin, 1998). Just as there are many theories about what causes autism, there are also many different views on treatments and therapies. Some try to address individual behaviours or skills and some take a more global approach. Some of these help to solve a specific difficulty, such as encouraging a more appropriate use of language, whereas other approaches have a more general impact on the individual's quality of life. Although this might not be noticeable or measurable in terms of cognitive or social skills, it could result to a reduction of self-injury incidents or to an improvement in willingness to share toys or the like.

Howlin (1998) presents a list of different treatments or therapies (the present classification has been added for clarity):

- *Alternative*: Some physical therapies have been found helpful but evidence is weak and anecdotal. The gentle manipulation of body and head in *cranial osteopathy* has been reported to improve hyperactivity; *music therapy* might help with emotion and communication, *pet therapy*, with social interaction, especially if it is used in conjunction with peer-mediated intervention; *physical exercise* in the form of 'patterning'. Trying to 'recover' damaged or unused neural networks is demanding and lacks scientific support, whereas some research indicates vigorous aerobic exercise reduces stereotypical behaviours and self-injury incidents, and improves hyperactivity, sleep, and anxiety.

- *Dietary*: Although there are some reports of improvement in behaviour with dietary interventions, the small size of samples and the negative effects in some cases make it essential to consider individual cases. Approaches require careful consideration of how the child reacts to gluten, casein, sugar, additives or any other specific foods, and individual assessment of whether the child can benefit from the addition of vitamins or minerals to his diet.

- *Educational*: A small number of educational approaches make use of intensive intervention, involving several sessions a day for up to seven days a week. The 'daily life therapy' program at the Higashi schools emphasizes group work and physical exercise, for instance. Among the intensive individual alternatives, Lovaas proposes a behavioural approach which could be successful at bringing children into the mainstream school. The child-led Son-Rise program at the Option Institute focuses by contrast on social interaction. Other approaches include 'Gentle Teaching', TEACCH and SPELL, the last two being very general rather than child-focused frameworks (described in detail by the National Autistic Society, 2005).

- *Prosthetic*: Facilitated communication is a controversial technique based on an assistant or facilitator supporting the arm of the person with autism while he types on a computer. It allows the individual to communicate, but the facilitator appears to be influencing the outcome in most cases. Even in the cases where communication is genuine, there is a constant dependency on the facilitator.

- *Psychological*: The use of psychotherapy with people with ASD has its origin in the early theories that included cold parenting as a cause of autism. Today it may be of benefit to some high functioning adults to deal with anxiety and depression, given their increased stress and great risk of developing an obsessive behaviour.

- *Sensorial*: This approach to helping people with ASD to cope with sensorial sensitivities uses a number of differing techniques, but claims of efficacy are not yet clearly supported by evidence. Auditory integration therapy, holding therapy, and scotopic sensitivity training (using tinted spectacles to filter certain wavelengths of light) each focused on one aspect of sensory input, whereas sensory integration therapy tries to help individual integrate and accommodate to all of the sensory information in any given situation.

What seems to make a difference to longer-term developmental outcomes in autism is early intervention (Jordan et al., 1998; Trevarthen et al., 1998). Many families in the UK tend to use a combination of different treatments, e.g.: diet, music therapy, speech therapy, and parent-based interventions such as the Son-rise program. The approach used in schools tends to be much more eclectic in the UK than it is in the United States (Knott, 1995). While some of the intensive educational approaches may use treatments such as Daily Life Therapy which uses a lot of physical exercise, when designing a program of intervention, it is very important to consider the individual's skills, abilities and difficulties, as well as the family circumstances, as these affect the way the strategies and techniques are implemented in a broader context, outwith the school setting (Howlin, 1998).

Many of the educational approaches are designed for early intervention, and they have a quite intensive format (around 40 hours a week or more), whether they are implemented at school (Higashi, TEACCH) or at home (Lovaas, Son-Rise). The fact that there might not be appropriate school provision for the particular needs of each family might lead a number of families to choose a home-based program. However, this option can be demanding in terms of both time and resources, and can prove to be a stressful experience in general (Knott, 1995; Jordan et al., 1998).

Part II: Social Interaction

1.2 Introduction

> *"Having a child with ASD has a major impact on the family. Besides the stress associated with bringing up a child who needs more attention and care, children with autism are not as social as*

other children and do not reach out to parents in the same way that other children do. This lack of spontaneous signs of affection from one's own child is very difficult for a parent". (Sicile-Kira, 2003, p.124).

Of all the challenges faced by children with ASD and their families, those relating to interactions within the social domain are of especial importance. It is not only the difficulty experienced in functioning appropriately in a social environment, or in building meaningful relationships with family members, including producing even basic signs of affection, that is of great significance when it comes to individuals with autism. Participating in small social units such as mother-child, child-peers, etc., provides a network from which to construct further relationships and to advance learning (Jordan and Powell, 1995). There is also a problem which is much more fundamental, however. The world in which we live is based on a social framework and it is through social interaction that we learn about the world. As Rogoff (1990) pointed out, the social context, such as society (including institutions and norms) and social partners (activities, routines, etc.), affect the child even without any direct interaction. Rogoff favoured Vygotsky's view of a social basis of the mind, where children's development emerges from immersion in the social world:

"*Vygostky assumes that social guidance aids children in learning to communicate and to plan and remember deliberately from the first years of life. This guidance provides children with the opportunity to participate beyond their own abilities and to internalize activities practiced socially, thus advancing their capabilities for independently managing problem solving*" (Rogoff, 1990, p.156).

In essence, social skills are as central to facilitating general learning as they are to improving appropriate social development and more general participation within society.

1.2.1 Educational Interventions

It has been widely acknowledged that early diagnosis, followed by specialised education, is the best form of intervention for autism, especially when trying to take advantage of neural plasticity to develop language and other psychological domains. Although a complete recovery cannot be guaranteed, many children with autism have shown an improvement in their skills and behaviour when receiving appropriate training or treatment.

Sicile-Kera (2003) cautioned that several factors require consideration in coming to a decision as to which therapy would be most appropriate for any individual with autism; these included age, level of ability, relative strengths and weaknesses, behaviours, learning style (auditory or visual), goals, and previous treatments, together with a regular reassessment of the situation at regular intervals. A combination of treatments might be a course of action, since most are not exclusive of others. Before making any decision on whether to start with a new therapy there are additional factors to consider, such as the risk for the individual, the financial demands, any implications for integration with other therapies, and the possible impact on the family in terms of stress, fidelity to the protocol, commitment, sibling relationships, etc.

As the focus of this thesis is on facilitating social interaction in children with autism, a number of educational interventions which are currently in wide use and which specifically target social interaction are outlined and discussed below.

Lovaas

The program designed by Ivar Lovaas is an intensive version of Applied Behaviour Analysis (ABA). In this, a skill is broken down into smaller steps that are taught one at a time, using prompting, shaping and reward (Sicile-Kera, 2003). Lovaas' method seems to work best if used for 30 hours a week, over two years and starting before age 5. Although it has been reported as being highly successful in terms of enabling children with autism to be integrated into mainstream schools, it has been mainly criticised for the mechanical social behaviour displayed by the children. To gain the most benefit from it, also requires qualified therapists, making it a very expensive program (Howlin, 1998).

Higashi

The 'daily life therapy' used at the Higashi schools in Japan focuses on behavioural improvement by means of group work and a strong physical education program. It seems to succeed at improving interpersonal behaviour but there is a lack of focus on personal development. It has also been criticised as being a somewhat rigid approach and insufficiently sensitive to individual characteristics (Howlin, 1998).

Gentle teaching

'Gentle teaching' was developed by McGee for people with learning difficulties in general and is based on a relationship between client and therapist and non-aggressive methods. It is generally not judged to be as successful as other therapies in reducing aggressive or self-injurious behaviours in children with autism (Howlin, 1998).

Son-Rise

The main focus of the Son-Rise program, from the Option Institute, is to make social interaction pleasurable and more interesting than simply interacting with objects. This approach involves intensive one-to-one sessions with the therapists (parents and trained volunteers) and anecdotal reports suggest that children seem to become more cooperative and happier. However, there is little scientific evidence of its success (Howlin, 1998; Williams, 2001). The centre of the programme is the child as a leader of a playful interaction, emphasizing acceptance and eye contact in a distraction-free playroom. This seems to be more effective with very young children, and it may be suitable for some children more than others, depending on intellectual potential. It demands a lot of dedication from the parents, not only to the therapy programme itself but also in terms of finding and training volunteers. The 'Growing Minds' program has been developed as an alternative. This combines a social development focus with a skill development focus and was constructed by Steven Wertz, an experienced Son-Rise and ABA practitioner (National Autistic Society, 2005a).

TEACCH

The TEACCH program is based on a very structured environment, an individualised curriculum, and the use of cognitive and behavioural therapy, as well as requiring parents to collaborate in altering the daily environment and programme of their child in a similar manner. Adapting the setting to accommodate the child's deficits is as important as the educational methods. Division TEACCH is a research and training centre as well as a service provider based in the University of North Carolina (USA), but many schools in the UK incorporate some elements in their programmes, (National Autistic Society, 2005b).

SPELL

Drawing from TEACCH concepts, the UK National Autistic Society (NAS) has developed the SPELL framework (Structure, Positive, Empathy, Low arousal, Links), which emphasizes a structured environment, reduced expectations, low pressure and collaboration among the professionals and family (National Autistic Society, 2005c).

1.2.2 Naturalistic approaches

The above approaches vary in the emphasis that is given to developing social interaction. Some of them are quite specific (e.g. Son-Rise), whereas others tend to provide a comprehensive educational program, (e.g. TEACCH). Bearing in mind that many practitioners use a variety of techniques to target a particular behavioural difficulty, there are many more approaches than those mentioned here. However, most social skills training has been focused on isolated 'splinter' skills (Howlin, 1998b). Dunlop, Knott and MacKay

(2002) reviewed studies with reference to teaching specific social skills, such as initiating interactions with adults, eye contact, joint attention, appropriate conversation, and, more recently, skills essential to developing a theory of mind. They found that many of these interventions were effective to at least some degree within the setting in which children were taught, but that there were often difficulties in generalising the new skills to other contexts.

Some studies (Hwang and Hughes, 2000; Kamps et al., 2002) clearly highlighted that social interaction learning could not be isolated from daily life, and that a natural setting was necessary if the new skills were to be practised and consolidated. Considering these principles, Dunlop et al. (2002) set up a social interaction project organised as an after school club where children were involved in all sort of social activities: games, conversations, snack time, role playing, etc. The 38 children with autism were organised into six different intervention groups, meeting once a week for a period of 12-16 weeks. Even with a short intervention period, there was a significant and measurable improvement in their social interaction and understanding.

These interventions explored in this thesis are based on the double strategy favoured by the TEACCH approach: improving skills through education and modifying the environment to accommodate the typical interpersonal deficits found in autism (NAS, 2005b). The first strategy is based on choosing a real life learning activity such as play, and the second by using computers, a specific accommodation to the communicative style of children with autism, as explained further below.

1.3 Play

Defining play beyond a general 'fun and entertaining' activity is difficult, and it is better achieved by describing its characteristics. One of the earliest definitions of play was given by Huizinga (1938):

> *"[Play is] a free activity standing quite consciously outside "ordinary" life as being "not serious", but at the same time absorbing the player intensely and utterly. It is an activity connected with no material interest, and no profit can be gained by it. It proceeds within its own proper boundaries of time and space according to fixed rules and in an orderly manner. It promotes the formation of social groupings which tend to surround themselves with secrecy and to stress their difference from the common world by disguise or other means." (p. 13).*

In summary, Huizinga stated that play is free, absorbing, unprofitable, within boundaries and promotes social groupings. Caillois (1958) modified this definition slightly to describe play as free (not obligatory), separate (circumscribed to certain pre-set limits of time and space), uncertain (unknown outcome), unproductive, governed by rules, and make-believe *"accompanied by a special awareness of a second reality or of a free unreality, as against real life"* (p.10). Garvey (1977) also referred to a number of these characteristics, such as it being pleasurable and enjoyable, being without a goal imposed from the outside, spontaneous and voluntary, and involving some active engagement on the part of the player. Roeyer and Van Berckelaer-Onnes (1994) added that play should be flexible and engaging, with a non-literal orientation, and that it should prioritise the means over the end product, which is to say that it is the process rather than the outcome that is important.

The importance of play lies in allowing children to learn new skills and practise them in a safe environment (Boucher, 1999). Crawford (1982) explains that games allow children to experience conflict and danger without having to endure the consequences of their physical realisations, which, as in the case of some video games and simulations e.g.: flight simulators, might be serious damage or death (Griffiths, 1997). More specifically, social play also allows children to experiment with roles and interaction, which is the basis of developing friendship skills such as intimacy, trust, negotiation and compromise (Restal and Magill-Evans, 1994), but without the anxiety that a real life situation may generate, especially in children with ASD who find these social contexts more challenging.

Learning about social skills in the context of play has an important effect in the proxemics of the interaction: children may allow others to breach their normal zone of comfortable distance without feeling threatened, and this may help to enlarge both the zone of personal space within which interactions can be attempted or the range of people accepted in that zone (Restal and Magill-Evans, 1994). This is even more important when dealing with children with ASD who often find the usual social settings of childhood typically too stressful to engage in.

1.3.1 Autistic Play

All children play, and children with ASD are no exception. It is easy to assume that individuals with ASD do not play as they might not engage in play in a conventionally recognized way (Donnelly & Bovee, 2003). This is why observing social play is essential in identifying and diagnosing autistic spectrum disorders (Jordan, 2003). There are specific forms of play, such as chasing and 'rough and tumble' play, where children with autism display social skills rarely seen in other contexts, for instance (Beiberich and Morgan, 1998).

In general terms, children with autism tend to be more preoccupied with objects than with people. This prevents them from engaging more in interactive play when compared to their peers. They also seem to restrict their play to simple manipulation rather than to engage in pretend play: for example, given a toy car, a child with autism may spin the wheels instead of pretending to drive or race with it (Deudney, 2005). Nevertheless, children with ASD can engage in pretend play when it is elicited and very structured, but their main difficulty is in the initiation of this type of play (Wolfberg, 1999). It is possible that the difficulties experienced when previously attempting to engage in social play may have resulted in repeated failure and frustration, with this in turn destroying their motivation to engage in any kind of play (Stahmer, 1999).

The problem is that not engaging in play with others can cause social isolation and can prevent children with autism from developing and practising new social skills (Boucher, 1999). In addition, the type of play preferred by children with autism does not seem to attract the interest of their peers, who typically do not engage with them (Williams et al., 2001). This generates a no-win context in which children with autism do not engage in the play of their peers and vice versa, both missing out on interactive play.

If general learning takes place in a social context, as detailed in previous sections, a lack of involvement in all forms of social interaction is clearly an obstacle in the learning process. If key skills are learned through play, and if children with autism do not have the social skills to engage in the necessary play, then it seems reasonable to hypothesise that learning to play might unlock their social learning. In addition, teaching children with autism to play could provide them with an opportunity to experience mastery which in turn could increase their motivation to play (Boucher, 1999).

If the relevance of teaching play skills is accepted, it is important to point out that peers provide a highly eliciting situation for pretend play and for social interaction (Wolfberg, 1999). On the other hand, Dunlop et al. (2002) have emphasised the need for real life activities and for a natural setting in which to practise those skills. Play is a real life activity, and peers are real life social partners who have the potential to be ideal teachers for children with autism. In fact, children with autism seem more responsive to their siblings than their parents where play initiations are concerned (El-Ghoroury and Romanczyk, 1999). Whether this is the consequence of children with autism being more responsive to other children, or other children (their siblings in this case) being more naturally in tune with other children, including those with ASD, is not known. The point is that peers might be better 'therapists' than adults, and, if the 'therapy' is based on playing, when interacting with a peer the child with autism not only increases his age-appropriate social network but also the possibility of being mentored by these peers.

In summary, children with autism should learn to play: it is the way children learn and interact on a daily basis, it is safe, it can cross interpersonal barriers and ultimately, it is a highly motivating route to knowledge.

1.4 Communication theory

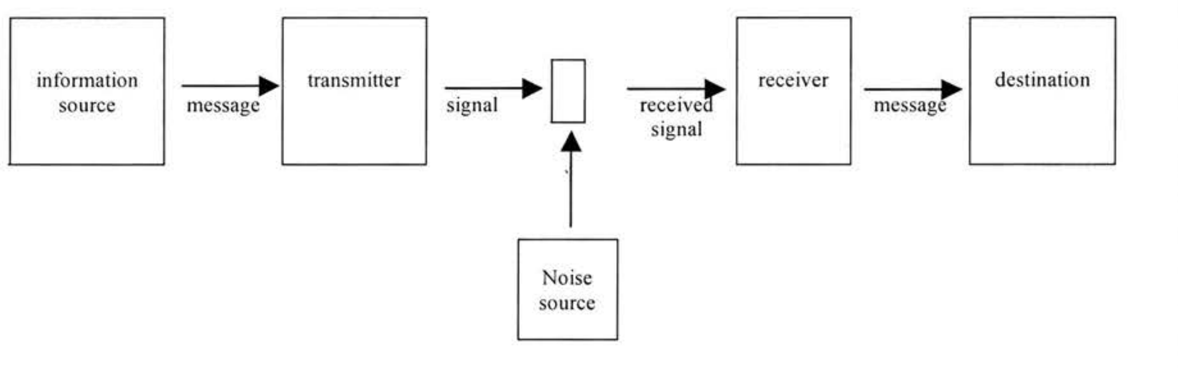
Ordinary people may experience communication difficulties in an extraordinary situation such as a job interview, an exam, speaking a foreign language, speaking in public, etc., all of which might cause a degree of anxiety, confusion or misunderstanding. For people with autistic spectrum disorders (ASD), most everyday situations are potentially a cause of anxiety, confusion or misunderstanding. In order to modify the environment to accommodate their communicative needs, it is necessary to analyse the communicative process itself.

There are several models of communication, of which only a few have been summarised here, under the criteria of being relevant to the ASD style of communication.

1.4.1 Communication models

Communication may be understood as the set of procedures that one mind uses to affect another. This is the definition that Shannon and Weaver offered in 1949 (see Figure 1.1). Their model is still widely used in communication theory literature today.

Figure 1.1: Shannon and Weaver's communication model.



Shannon and Weaver's model applies to human communication, but is not exclusive to it. According to the model, an information source chooses a message which is transformed (coded) into a signal by the transmitter , which sends it through the communication channel to the receiver where it is transformed (decoded) again into a message to be handed to the destination. During this process it is frequently the case that outside elements are added to the message, causing some distortion, referred to as noise.

Laswell (1948, as cited by Morgan and Welton, 1992) stated the elements of a communicative process through the question "*who says what in which channel to whom with what effect*". It offers an equivalent model to that of Shannon and Weaver.

Morgan and Welton (1992) presented the model of Schramm (1973), who proposed that two entities must share a common experience or "life-space" in order to communicate successfully. Thus:

> "*the successful communicator will identify those areas of <u>common interest</u> shared by both parties and use those areas as a means of carrying the message*". (p.134)

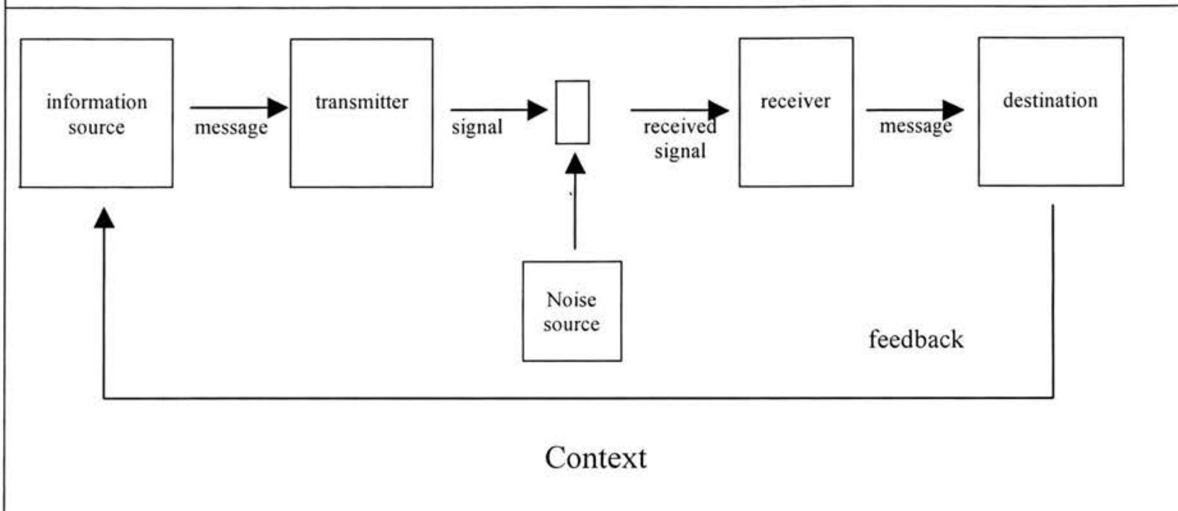
The authors also summarise Berlo's model (1960):

> "*Sender and receiver have to share the same set of skills: they have to use the same language or code, and they have to use words or signs in the same way. For this to happen, they must have experience of the same social system and culture (the values, rules and beliefs through which people live).*" (p.10)

Berlo also distinguished between the content of the message, the individual elements, the structure within which they are combined, the treatment (subtle variations that change the final message) and the code. Morgan and Welton added that: "*successful communication requires the active participation of both sender and receiver*" (p. 133).

Hargie, Dickson and Saunders (1994) updated the elements of communication that were found in more recent research including communicators, message, medium, channel, noise, feedback and context. Although medium and channel are frequently confused, the first is the system of symbols (e.g. an image, a language) and the second is what accommodates the medium (e.g. a visual or auditory channel). In this model, communication is a bidirectional process where the sender is a receiver, and the receiver is a sender at the same time, by means of the feedback. It also takes into account the context in which communication takes place in terms of geographical location, time, relationships, etc. (see Figure 1.2, over).

Figure 1.2 Shannon's model with new additions: feedback, context.



Hargie et al. (1994) have also been concerned with what makes people communicate and the motivations behind social interaction. Going through the relative literature, they found three main reasons for communicative interactions:

1- need for control and prediction of what happens to oneself

2- need for a sense of belonging and approval

3- need for competence and sense of self-worth

In considering the bidirectional dimension of communication, Elsom-Cook (2001) defined it as interaction, and when it is directed to change the internal state of the communicators, agents in our paradigm, then it is communicative interaction. Elsom-Cook distinguished between physical and communicative interaction.

Shannon and Weaver (1949) also considered the different level at which difficulties might occur. The first level refers to the accuracy of transmission of symbols, the second to the accuracy of conveying the intended meaning, and the third to how effectively the received message affects the conduct of the destination as expected.

In summary, a communicative process presents language, context (implicit meanings, social cues), multi-channel means (verbal, non verbal), and noise (light, sound, distractions), as well as a source and destination for the message, and it is regulated by the motivation of both parties.

1.4.2 Autistic Communication

Within the communication theory framework, message, channel or code and context are the elements of main concern for people with ASD, just as they are in standard communication.

There are three relevant issues worthy of attention here. First of all, Schram (1973) highlighted the need for a common interest between the parties for successful communication to be accomplished, and people with ASD have the same requirements. What might vary is the scope of interests they have, and this limitation leads Lesser and Murray (1998) to define their problem as attention-tunnelling or monotropism. Finding out about their interests is the key to enhancing motivation for social interaction, whether direct or computer-mediated, especially given that individuals with autism typically have a motivational profile that differs from that of the general population. According to Hargie et al.'s (1994) findings, people with ASD might be less motivated to interact by any drive to achieve a sense of belonging or approval. On the other hand, they might be more motivated than the average person by a need for control and predictability in their surroundings, a drive directly related to their difficulties coping with change.

Secondly, the channel refers to the way in which the information is conveyed. It can be verbal, non-verbal, visual, etc., and at times can be a combination of these, according to the relevant code (i.e.: language). Information could be delivered by using eye contact, body language, turn-taking and other social rules, along with speech. As Tony Attwood (2000) has suggested, if working from a point of view that emphasizes the strengths of the person with ASD, making the message more visual is 'a must' when attempting to communicate with him/her.

Lastly, Vermeulen (2001), an autistic adult, has described communication as a process based on coding and decoding, and interpreting and re-interpreting. He stated that people with autism have difficulties with interpretation, especially with what is not being said and what is the underlying purpose of the message. This purpose is generally clear from the context, but people with autism may fail to recognise it. The context not only provides information helpful to interpreting a message which might otherwise be ambiguous, but also involves the recognition of extra stimulation that may interfere with the communication process. If that is the case, the person with ASD might feel overloaded by incomprehensible stimuli, and shut down to the communication, or exhibit an unpredictable behaviour.

1.4.3 Adapted Communication

The communicative process requires certain elements to be present. Problems with any of these individual elements, separately or in combination, can cause difficulties within the whole process. If the information is given in small segments (one unit at a time), via a structured, noise-free, unambiguous medium, with extensive use of visual representations, giving the necessary time for the person with ASD to process the message, then a successful interaction or communicative process might be more likely to take place.

Computers can provide all of the above communicative features. Murray and Lesser (1999) state:

> *"A computer is unthreatening and controllable. It provides a comfortable environment which facilitates therapeutic transactions in which communication, sociability and imaginative play spontaneously occur"*. (p. 2)

They define the following attributes as being inherent to interacting with a computer: the communication is contained, has very clear-cut boundary conditions, is naturally monotropic, context-free, rule-governed and predictable (and thus controllable), allows for safe error-making, is a highly perfectible medium, and includes the possibility of non-verbal or verbal expression. Importantly, it also allows another individual to join in with the individual's attention tunnel. For all of these reasons, it seemed a good candidate for exploring possible ways of enhancing social interactions in those with ASD, the focus of this thesis.

Chapter 2: The potential of computers in autism-specific education

The previous chapter justified the need for a naturalistic approach to social interaction therapy for those with autistic spectrum disorders. In the case of children, play not only fulfils this criterion but is also a common activity amongst all children, providing frequent opportunities for learning and interaction. It was also proposed that computers provide an environment that facilitates an adapted communicative process, as required by people with ASD. This chapter introduces games as a particular case of play, and their therapeutic possibilities, and reviews the use of computers with children with autism. Against this background, the use of computer-based games is suggested as a potential tool to foster social interaction in children with ASD.

Part I

2.1 Access to computers

It is a widely-held opinion amongst experts who use computers with people with ASD that they find them useful in terms of the positive impact they have on their communication and social skills, leading Murray (1997) to insist on the need for ensuring access to computers for people with ASD. More evidence supporting this will be presented in Chapter 3. This chapter will first explore accessibility issues and how computers are currently used with those with ASD in educational contexts.

If the potential of computers for people with autism is to be realised, they have to be used appropriately. Parents, teachers and therapists have a front-line responsibility in ensuring this as they are the adults in closest contact with the individual with ASD. Teachers and therapists could have more opportunities to interact with people with ASD through greater computer use, thereby obtaining wider and possibly deeper insights into the condition. Computers can also provide more opportunities to practice different interventions or approaches. As professionals are often consulted by parents who have just got the diagnosis of their child, they can also play an important role in promoting the use of computers and advising on how to proceed.

In a more general framework:

> *"New applications of technology have the potential to support learning across the curriculum, and allow effective communication between teachers and learners in ways that have not been*

possible before. For this to happen, teachers are responsible for translating into practice the high expectations and the visions of technology enthusiasts." (Dawes, 2001, p.61).

This means that teachers hold the key to promoting the appropriate use of computers in educational contexts.

Dawes (2001) pointed out that the factors that limit the use teachers are making of ICT in the classroom can be very basic: inappropriate equipment, poor training and a lack of time to evaluate applications. Doubts about the pedagogical purpose of computers is also widespread, however, the introduction of ICT training and funding can have an impact in teachers opinions as it has happened in Scottish schools where teachers have gained confidence and knowledge and the majority now hold a positive attitude regarding the potential of ICT in their classroom (Condie and Munro, 2005).

Access to computers and other equipment increases year on year. In Scotland the computer to pupil ratio was of 15 to one in primary schools, with new funding aiming at increasing the access to 7.5, and 5 to one in secondary schools (Condie et al., 2002). According to Prior and Hall (2004), the computer to pupil ratio in England in 1998 was 1 computer to every 17.6 pupils in primary school, 8.7 in secondary schools and 4.7 in special schools. This ratio rose in 2004 to 7.5 in primary, 4.9 in secondary and 3.0 in special schools, meeting the government's targets. 60% of secondary schools reported that they provided all their students with an email account, and 99% of all schools were connected to the internet. A majority of schools also had interactive whiteboards, digital projectors, printers, scanners, and digital and video cameras, with a few also having video conferencing facilities.

All this shows wide access to technology in English schools, where at least 70% of its use is for learning and teaching, with this on the increase. Also, 9 out 10 schools (of all levels) said that their school leaders and teachers had received adequate computing and technology training, with respondents estimating that at least 80% of teaching staff were confident or very confident using ICT. A survey study across 52 primary and 47 secondary schools in Scotland, involving over 400 teachers, (Condie and Munro, 2005) showed that more than 90% of the teachers had access to a computer at home, and the majority was connected to the internet. They used the computer at school mostly for word processing, searching the internet, the creation of curriculum material and emailing. These figures suggest that most obstacles to access have been removed and that the use of computers for teaching and learning is rapidly increasing.

On the other hand, children's opinions about their access to computers at school draw a slightly different picture. In a survey with 2073 participants, pupils in England indicated that their teachers use computers mainly in ICT (87% of respondents), English (52%), design and technology (49%), science (47%) and mathematics (43%) lessons, but that the limiting factors on their usage of computers were the lack of time (37%) and lack of computers (25%) (Hayward et al., 2002). Taking into account the increased computer to pupil ratio indicated by the latest statistics, it has to be assumed that a child's perception of there being an 'insufficient number of computers' is directly related to how much time he or she has to wait to have a turn, and therefore, that the ideal situation is going to be a 1:1 ratio.

The school is not the only place where children have access to computers, however. In Scotland almost 90% of children have access to a computer outside school, 86% of which are linked to the internet (Condie and Munro, 2005). Hayward et al. (2002) found that 81% of households in England owned a computer, with 68% having access to the Internet. Regarding children's usage, 98% of 5-18 year olds had access to computers, with 92% having access at school, 75% having access at home, and 46% accessing them elsewhere. The majority of child respondents (83%) also used the internet, with 71% accessing it at school and 56% accessing it from home.

Hayward et al. reported that 89% of children in Key Stage 3 and above enjoyed using computers and 76% of those in Key Stage 1 and 2 thought that computers made school work more fun. According to Downes (1998), the majority of children prefer to use computers at home rather than at school, but Stark et al. (2000) found that the frequency of use at home was lower than at school, although the range of use was wider (see also Hayward et al., 2002). At home children find a quieter environment, they are in control of the system (they do not have to fight for their turn), access is less restricted and, in many cases, this is to a more powerful and reliable machine (Downes, 1998). In summary, most children enjoy using computers and use them frequently at home and in school.

2.2 Educational uses of computers

It is clear that computers are widely available in schools, and that they are being used mainly to support ICT lessons, Science, Maths, and English. There is a great availability of subject-specific software that supports the drilling of literacy and numeric skills, allows experiments with science simulations or can even provide a guided virtual tour to life in another civilisation (see Bennet and Tuff, 2004). Teachers are also using the internet as a resource base (Prior and Hall, 2004), but there are more educational uses that are currently being explored with the introduction of new forms of technology.

Crook (1994) advocated a move from interaction with computers as a means of simply transmitting knowledge towards the use of computers as a context for social interaction:

"If we do not wish to see new technology transform the experience of learning into something solitary and dislocated – then we must demonstrate that it has a credible place in a more collaborative framework" (Crook, 1994, p.223).

He states (p.188) that computers' input and output devices demand a *"narrow focusing of attention and action"* from the user, and that their graphic capabilities, by allowing the user to manipulate abstract material in a concrete format, can facilitate the sharing of knowledge during peer collaboration. He further distinguishes interactions around technology (e.g.: a computer network in a classroom, with students talking to each other) and interactions through technology, which may take place in a different time and space context (e.g.: video conference, e-mail).

This emphasis on interaction and collaboration is now being realised in schools. For example, the Scottish Schools Digital Network is investing £37.5 million over five years to help build virtual learning communities which will use different collaborative tools such as videoconferencing, social software that supports co-operation and on-line resources (Blane and Macdonald, 2005). As an example, a geography teacher could use digital pictures, animated graphics and 3D imaging to enhance presentations, improving understanding when compared with traditional media:

"Before, you would show the acetate and 20 per cent of the students would get it, with the other 80 per cent struggling. With the use of exciting images, 80 per cent of them can get it now" (Clark, 2005, p.5).

Multimedia is a term that refers to a combination of multiple technical resources in order to represent information in multiple formats by means of multiple sensory modalities (Schnotz and Lowe, 2003). It is a generalised opinion that multimedia presentations are better than traditional presentations such as books, but, although the above quote illustrates the multimedia principle that children who learn from a combination of words and pictures perform better when tested for transfer and retention (Mayer, 2001), it is not clear if they are, or by means of which mechanisms they are (Narayan and Hegarty, 2000; Schnotz and Lowe (2003).

On one hand, Paivio (1986) proposed a dual coding theory to explain the fact that textual information is remembered better when it is presented together with pictures than when it is not: textual information is only processed and coded in a verbal cognitive subsystem whereas pictures are processed and coded in an imagery system as well as the verbal system. On the other hand, Schnotz and Bannert (2003) question Paivio's theory arguing that verbal representations are descriptive and pictorial representations are depictive, and a mapping between the two is not possible, but this may be only theoretical considerations of little consequences in the practical field (Reimann, 2003), in which other researchers have found that the dual channel theory applies (Mayer, 1997).

The key question, when comparing computer versus printed presentations, is whether the outcome depends on the medium or on whether their design has taken into consideration the learners cognitive processes. Narayan and Hegarty (2000) found that multimedia presentation do not improve learning over traditional media (verbal explanations illustrated with diagrams) because of the medium of presentation, thus, if there is learning taking place and it is not due to the medium, it points at the design as the element conducive of learning.

Further research has found evidence of the relevance of the design. A study comparing two different media environments (text and illustration versus narration and animation), concluded that when an instructional method takes into account the limited capacities in working memory of the visual and verbal channels, then learning is enhanced (Mayer, 2003). The fact that the information provided through these channels comes from a book, a computer, or other media is irrelevant, according to Mayer: "Media environments do not cause learning; cognitive processing by the learner causes learning" (Mayer, 2003, p.137).

Other researchers have been more specific: pictures facilitate learning when the type of information conveyed is of explanatory nature, when the visual and verbal information are related to each other and presented together in space and time, and when the learners have little knowledge of the subject domain but good spatial cognitive abilities (Mayer, 1997; Schnotz and Bannert, 2003).

Regarding animations, (dynamic graphics) multimedia designers seem to advocate their use whenever possible, but their real educational value is not clear, since they could be detrimental for learning due to their high cognitive load and the lack of coherence between their perceptual salience and their conceptual relevance (Lowe, 2003). Lowe found that learners without high subject domain knowledge tended to consider more relevant the most salient features of animated information, while they tended to miss out very important yet more visually subtle information. In summary, multimedia information can enhance learning, but it has to be appropriately designed taking into account the learning style and domain knowledge of the intended audience.

While the research presented here is not concerned with learning per se, it is important to acknowledge the fact that a good game design shares some principles with good instructional design. In order to enhance the usability of a play based task the cognitive load and multimedia features have to be considered, and the issues about the role of the medium are key to this thesis, as it will be explored in later chapters (Ch.4 and Ch.6).

As for creative and social uses of technology, there is a Virtual Buddies project set up in a Scottish school (Blane, 2005a) that helps children in transition from Nursery to Primary school by the recording (with web cameras) of the stories told by Primary school children and the combining of this with some face-to-face sessions, thereby ensuring that the Nursery pupils will have familiar faces when they join the Primary group. Another teacher is experimenting with interactive voting systems so he can get instant feedback about children's understanding of what is being explained, although the system only allows yes/no and a, b, c, d answers, and preparing the questions seems time consuming (Blane, 2005b). Ross (2005) also reports on the E-Lamp project, a computer-based initiative which provides children of the seasonal travelling community with laptops and a satellite communication system to maintain contact with their base school through email

Computers are also being widely used to encourage collaborative working and writing. Web logs, for example, are an internet-based journal system, which allow users to publish content in the form of chronological postings which get archived after a period of time. There are online tools that facilitate the creation of such pages and the educational possibilities range from being used as classroom portals or discussion sites, to store student portfolios, or to support group work (Manuel, 2005). Lohnes (2003) reported that:

> *"[..] Student commented on each other's paper drafts and worked in groups on their research projects. They did a lot of writing (by the end of the term, about 100 pages each) without realizing how much they had done. For many of them, the writing became a 'fun' activity rather than something that was seen as drudgery or a hurdle to be overcome"* (Lohnes, 2003, p.2).

On a more thesis-specific note, one area where computers are being used widely is in special schools. A variety of academic learning needs can be met by the use of technology and many of the obstacles presented by e.g. visual impairment or motor difficulties can be overcome. Voice activated software, or typing on a keyboard, for example may allow a pupil to produce a neat essay instead of an illegible manuscript with spelling mistakes (Franklin, 2001). There is also one further aspect of computer use that impacts on the quality of life of a student with special educational needs, the 'cool' factor:

> *"A Year 8 pupil with cerebral palsy who was otherwise very bright was rapidly becoming a school refuser. It transpired that her shaky handwriting meant that she could not keep up with other children with the note taking involved in her top sets. Although a learning support assistant was*

available she did not want to appear different by having her notes scribed. Once issued with an Emate computer her attitude and attendance were transformed. Other pupils saw the Emate as 'cool' – they wanted their own in fact and so the pupil now did not mind being different. In fact, she would even let her learning support assistant touch type on occasion." (Franklin, 2001, p.112).

As shown above, communication and fun have been pointed up as key factors in learning through computer use. People are getting connected over the internet, exchanging ideas and resources, and creating specific interest communities. This is encouraged in schools together with collaborative projects. On the other hand, there is a growing emphasis on motivating children to learn, something which is easily achieved if they are having fun, as many educational games are designed to do (see Bennet and Tuff, 2004). Computers and technology are a tool for communication and learning which is perceived by children as fun to use - *"but if you use paper it's like 'Maths' again – boring"* (Blane, 2005b). Using computers may seem more play than work to some children, even if it is for school subjects, and this thesis therefore tries to explore the possible educational benefits of playing 'real' games with computers. The term 'real' is used to emphasize that the games played are not meant to be openly educational, but are rather designed to entertain.

2.3 Games, computer games and children with autism

2.3.1 Games

In a classic text on games, Avedon and Sutton-Smith (1971) analysed the history, taxonomy and utility of games, raising issues which are now being rediscovered with current interest in computer games and learning. Prensky (2001) notes that in order to learn a new skill, or, in other words, to rewire the brain, it is necessary to spend several hours a day, five days a week, with focused attention to the task, which is exactly what videogames players do. Avedon and Sutton-Smith define a game as:

"An exercise of voluntary control systems, in which there is a contest between powers, confined by rules in order to produce a disequilibrial outcome." (Avedon and Sutton-Smith, 1971, p. 7).

This description falls within the general definition of play as a pleasurable and enjoyable experience, with no specific aim imposed from the outside, and which is spontaneous and voluntary, involving some active engagement on the part of the player (Garvey, 1977). Play is unique, individual, ephemeral and open-ended, whereas a game is systematic, can be repeated and has a given goal (Avedon and Sutton-Smith, 1971). In other words, games are a specific kind of play, with a predetermined goal and rules structuring the way in which such a goal may be achieved. This rule-based activity is particularly suited to the computer medium, because rules are easily programmable, and it could also be argued that it is a form of play particularly suited to individuals with autism because of those clear rules.

However, there are more definitions of games such as the one given by Crawford (1982), to include aspects of representation, interaction, conflict and safety (mentioned in Ch.1). Crawford understands games as a simplified representation of subset of reality where interactivity is essential and a conflict between two agents has to be resolved. Although games are generally a social activity, there are several solitary games where the interaction, instead of being held against an opponent, focuses on a different agent, which could be fortune, time or one-self. Conflict resolution leads to competition but it is possible to include a cooperative element if two players collaborate against a third agent, e.g.: another team, an individual or a computer simulated player, (Crawford, 1982).

Furthermore, conflict is not necessarily a negative feature, but the equivalent to goals in other definitions (Avedon and Sutton-Smith, 1971): something has to be achieved and the obstacles presented during the game have to be resolved and, although in theory they 'get in the way' of victory, these obstacles are what makes a game fun (Juul, 2003; Gee, 2003). In the case of children with ASD, who sometimes display low tolerance to frustration, this feature of games may raise concerns, but in practice, at least within the computer games domain, children with ASD seem to enjoy the same games as their peers (Lehman, 1998b). It has been observed during the pilot studies and experiments presented in this thesis (Ch. 4 to 8) that children with ASD coped reasonably well with frustration (from losing) while playing games.

It seems that different scholars bring in complementary definitions rather than conflicting ones, by looking at different aspects of games. For example, Salen and Zimmerman (2003) contribute with the definition of three game design schemas that try to convey the complexity of games. In these schemas the scholars try to frame and organize knowledge related to *rules*, which focus on the essential logical structures of a game, *play*, which focus on the player's participation with the game and other players, and *culture*, which focus on the cultural contexts within which games emerge and are played. These schemas are again focused on rules and interaction (which includes Crawford's interaction and conflict), but introduce the concept of culture. In part, it is the culture what may be present in what Crawford defines as a representation of a reality (read culture), but Salen and Zimmerman include the context in which game playing takes place, that is, for example, a sporting event as part of a village celebration, or a regular gathering of friends in someone's home to play video games. The concept could be extended to the society's perception of game playing, i.e. something appropriate (or not) for adults. In a more specific note, it has to be pointed out that the current climate is that it is 'cool' for children to play computer games, which can improve the social status of children with ASD.

Bjork and Holopainen (2003), talking from a computer-game context, considers gameplay as the essential part of a game, and defines it in terms of the interaction of a player with the game and other players, including the possibilities, results and reasons for a player to interact with a game or, in other words, what a player has to do and why, in order to win a game. This quality is for Bjork and Holopainen the deciding factor to judge a "good" game, above interest, novelty or fancy graphics, but it is a very subjective element and Bjork and Holopainen do not risk describing what makes a game fun, since it will be different for each game, each player and even each time an individual plays with the same game.

For Fullerton (2006), whose definitions also come from the computer gaming domain, games are not only formal systems of rules that define player action and goals, but also an immersive experience in which players have the opportunity to assume the role of a character in a story. This role playing feature is not present in many games (e.g. card games), but it could be found in games when there is apparently no storytelling of any sort: if we considered a football game (or any other team sport) as a metaphor of a battle, then the players could be assuming the role of the warriors who engage in a fighting contest. Again, although this feature could not be part of a definition that tries to be valid for all sorts of games, it brings the issue of role-playing through computer games, which has the educational potential of rehearsing some social interactions for children with ASD.

It appears that some definitions focus too much on the computer game domain, which is just a subset of games, but their presence among the children of today, including children with ASD, makes them a predominant subset of games of great influence which are shaping the game culture of the future. Computer games have given more relevance to the game designer who "creates the rules of play, thinks up the dramatic premise, and works with the development team to create a compelling placer experience" (Fullerton, 2006, p.39). Everything is decided by the game designer, but, as Pearce (2006) describes, games (online computer games at least) have evolved to allow the player the creation of objects, characters and even storylines, thus having an input in rule definition which is to say, players can change the rules of the games. This process may present a challenge for game theorists who will have to adapt their proposals to include the changing landscape of gaming.

In this line, and after reviewing the main definitions of play and games as given by Avedon and Sutton, Caillois, Crawford, and Huizinga among others, Juul (2003) tried to integrate them into a new general definition of game:

> *"A game is a rule-based formal system with a variable and quantifiable outcome, where different outcomes are assigned different values, the player exerts effort in order to influence the outcome,*

the player feels attached to the outcome, and the consequences of the activity are optional and negotiable." (p.6).

In other words, a game consists of a set of rules that define how a goal may be achieved and the consequences of doing or not doing so. Within this framework it is fairly easy to understand what is right or wrong, and, by means of playing the game repeatedly, experience a variety of outcomes, which are both valuable features for children with ASD who may find it difficult to understand the complexities of the world around them.

Elements of Games

The basic elements of games are the number of players, the rules that govern the action and the results, together with the strategies, which do not, themselves, belong to the games but are brought in by the players (Avedon & Sutton-Smith, 1971). In a more detailed analysis, Avedon (1971) proposes ten essential elements in games:

1. purpose of the game: aim or goal.
2. procedure for action: specific operations, required courses of action, method of play.
3. rules governing action.
4. numbers of required participants.
5. roles of participants.
6. results or pay-off: values assigned to the outcome of the action.
7. abilities and skills required for action: cognitive, sensory-motor, and affective domains.
8. interaction patterns:
    a. intra-individual: action/thought within the individual mind/body, without contact with another person or object (e.g. finger-flexion tricks).
    b. extra-individual: action directed towards an object, without contact with another person (e.g. a jigsaw puzzle).
    c. aggregate: action directed towards an object in the company of others doing the same, without contact with another person (e.g. Bingo).
    d. inter-individual: competitive action between two individuals (e.g. tennis).
    e. unilateral: competitive action between three or more people, with one acting as antagonist (e.g. tag).
    f. multi-lateral: competitive action between three or more people, with no antagonist (e.g. poker).
    g. intra-group: cooperative action between two or more people (e.g. cat's cradle).

    h. inter-group: competitive action between two or more intra-groups (e.g. soccer).
9. physical setting and environmental requirements.
10. required equipment.

In an in-depth analysis, games present many more dimensions. The different values of these dimensions in a given game will determine its suitability for a specific group of children, and the behaviour generated by it. Body contact, bodily activity, chance determination of success, competition factors, use of space, time, and props, rule complexity, volume and distribution of participation, spread of winnership, institutionalized cheating, outcome clarity and challenges are among the thirty dimensions listed by Redl et al. (1971), for instance.

> "*Some recreationists felt that the most suitable games for anxious children to begin with were pencil and paper games in which the amount of interpersonal interaction was greatly diminished. Writing games such as 'Noughts and Crosses', provide opportunities for several youngsters to play together without focusing too much on one another, but rather on the material that is between them. Furthermore, a writing game tends to keep the excitement fairly low and is quite distant from the direct physically competitive or attacking situation*" (Avedon & Sutton-Smith, 1971, p. 349).

Games are not only a recreational experience that contributes to well-being, but also can have several therapeutic applications. Games can be used as a diagnostic tool by looking at the way a patient relates to other players, regardless of the game being played. They can be used to develop a relationship with a patient and then disregarded once the patient is comfortable with talking directly to the therapist. They can also be used to teach children with learning difficulties socially acceptable behaviours, such as taking turns or following the classroom rules. And, finally, they can be considered as an encapsulated social system which "*when a person has a problem with 'living', offers opportunities to 'practice' living*" (Avedon & Sutton-Smith, 1971, p.371).

Children and adults of all times and cultures have played games. There is a Sumerian game board from c.2600 B.C. and a complex version of the Noughts and Crosses game board was found in Egypt, dating c. 1400 B.C. However, not all cultures played games, and those which did not tend to be less advanced in technology, political and social organisation (Avedon and Sutton-Smith, 1971). In other words, the more advanced a society is, the more sophisticated its games are. In today's western society, technology is a major influence and, with the introduction of personal computers, it has permeated to the world of games with the continuous development of both simple and complex computer-based games.

To sum up, games are a subset of play activities that are socially and culturally important, involve one or more players, in collaboration or competition, indoors or outdoors, over a board, using pen and paper or, more recently, using computer-based technologies.

2.3.2 Computer games

Although Spacewar is generally considered to be the first computer game, it was developed in 1962, four years after William Higinbotham created Tennis for Two in 1958 using analogue computing (Brookhaven, 2006), and ten years after Sandy Douglas created OXO, a computer version of Noughts and Crosses, to date the first graphical game (Winter, 2006). These were followed by chess programs and the first role-playing game, Adventure, along with many other games intended for arcade machines. In the 1980s game consoles started to be widespread and greatly influenced the development of different genres. The 1990s witnessed the battle of the dedicated machines, with personal computers emerging as a new platform from which to play games. It is also possible now to play with multiple players in a local network, where players are physically in close proximity, or over the internet, where players may be on different continents (Friedman, 1995; Egenfeldt-Nielsen and Smith, 2003).

Although there is a distinction between coin-operated games played in arcades among other youngsters, video games played at home on dedicated consoles or hand-held devices, and computer games played on a personal computer, children do not seem to make such distinctions and use the term 'computer games' to refer to all of the above (Sanger et. al.,1997).

Current computer games may be classified into the following categories (Griffiths, 1993):

- sport simulations.
- racers (sports of racing nature).
- adventures (imaginary worlds with imaginary identities).
- puzzlers.
- 'weird' games (unclassified).
- platformers (running and jumping on platforms).
- platform blasters (involve blasting every object or character that appears on screen).
- beat'em ups (involve physical violence).
- shoot'em ups (involve violence using weapons).

Sanger et. al. (1997) also add the following:

- flight simulation.

- role-playing.
- conceptual simulations.

Coin-operated arcade games are played in a public setting, surrounded by peers who make it a social experience with a competitive element. On the other hand, the private setting of home video games provides a very different environment that changes the nature of interpersonal competition when the opponents are members of the family. In the early 1980s, Panelas (1983) suggested that the direction of the overall markets in this context could have considerable significance for video games as an organized social activity.

This forecast could not have predicted the development of networked gaming, where what a player does affects the whole game development and outcome. As Schleiner points out:

> "*Multiplayer games can be very social. In the shooter genre, players sometimes band together into 'clans', groups who fight against other groups. Sometimes the social bonds developed in these clans extend beyond the game into friendship*" (Ahuna, 2001, p.1).

Possible risks associated with computer games

More than 81 % of English households have a computer (Hayward et al. 2002) and almost every home has at least one television, with 50% of children aged between 10-15 having a set in their bedroom (Sanger et. al. 1997). At the same time, there is a move towards parents limiting to a much greater degree unsupervised play outside the home. While machines such as computers and televisions provide a form of entertainment that can be enjoyed inside the home:

> "*many children are being left to their own devices, unsupervised at home and 'looked after' frequently by those electronic child minders, the television, VCR and games machines*" (Sanger et. al. 1997, p. 154).

In this social context, it is not surprising that the average North American child watches 25 hours of television, plays computer or videogames for 7 hours and accesses the internet from home for 4 hours a week, a total of about 5-6 daily hours of screen-based activities over and above school based computer-use (Gentile and Walsh, 1999). In the UK, children aged 6-17 spend around five hours a day with different media, a figure similar to the US, with 2.5 hours devoted to watching television (Livingstone and Bovill, 1999, cited at Livinsgtone, 2002). This latter study found that British children spend 10% of their 'media' time watching videos and playing with computer games, with only a very small amount of time spent at the computer on activities other than playing. It is very likely that levels of media exposure are increasing:

a more recent study in England shows that children from Key Stage 3 upwards use computers for 10 hours a week, 6 of them at home, 3 at school and 1 elsewhere, with a third of this time spent in game playing (Hayward et al., 2002).

This amount of technological exposure can reasonably be expected to have an influence on children. Griffiths (1993) states that although some research has showed that most computer games have a violent content and encourage sexism and racism, many of the best selling games are not intrinsically violent. However, there are reasons for concern centred on the possible greater effect of the child's active involvement in computer games as opposed to his more passive role when exposed to violence on television (Griffiths, 1993). It would appear that violent video games may have a greater influence on those children who are already more aggressive, although Gentile et al. (2004) reviewed a series of papers showing that level of parental involvement had a positive influence not only in limiting viewing times but in understanding the content and their reactions to the violent material depicted. The authors highlight the fact that violent games released from 2000 on display a more sophisticated array of weapons, targets, graphics and storytelling, with the impact on children in all likelihood very different from the research findings on games reported in the early eighties; whether there is more or less cause for concern has yet to be investigated.

It has to be pointed out that computers do not have exclusivity in precipitating violent behaviour. It also co-occurs with engagement in some sporting events, in spite of the generally positive opinion that athletic sports build character (Avedon and Sutton-Smith, 1971). It is also known that some play activities sometimes include fighting, bullying and taunting behaviours which are "neither enjoyable nor intrinsically rewarding, at least for the victim" (Sanger et. al. 1997). Even cartoons can be very violent although they are not generally perceived as such (Griffiths, 1993).

It has also been argued that playing computer games may be socially isolating, preventing children from developing social skills, interacting with their peer group or forming friendships (Griffiths, 1993). This is not seen as an inevitable consequence, however, since children still prefer "to socialise rather than act alone", and to act physically, including joint activities in front of a screen (Sanger et. al. 1997). Vered (2001) explains that children may prefer to play video games in groups because *"playing usually incorporates a sort of spectator gallery where an audience interacts with the players, calling comments, giving instruction, and cheering" (p.3)*; he suggests that this helps develop social skills and relationships, more so than when children are just 'standing around'.

Another argument against computer games is that they prevent children pursuing other more educational activities. Again, this is not an inherently inevitable consequence of playing computer games. Griffiths

(1993) suggests that the number of magazines available for game players indicates that those who play a lot may also read a lot. It has in addition been shown that a problem-solving game of historical content can have a gathering effect in a school setting, with children being drawn in and having a lively discussion about it, although not always:

> " .... *there were a few cases where solitary children became very absorbed in games play or repeated viewings of videos and these experiences seemed to further their separateness from their peers"* (Sanger et al., 1997, p. 174).

Finally, there is a risk of computer games becoming addictive. For Griffiths (2001) computer games, together with other technological addictions, are a subset of behavioural addictions. If the computer is played as a form of escapism or for its "tranquilising properties", once the primary problem is resolved the computer addiction also disappears. Individuals who display compulsive behaviour may need closer monitoring (Griffiths, 1993) but in general, addiction is not currently viewed as a major problem by the field. In the case of autism, spending too much time with computer games is more likely to reflect an obsessive interest in the game than a form of escapism per se, but nevertheless offers a more socially-acceptable alternative to other repetitive behaviours and requires more self regulation than some commonly-occurring autistic behaviours.

Possible benefits associated with computer games

If used wisely, computer games may be beneficial on a number of fronts. Some possible educational benefits are that computer games are motivating, generate discussion, introduce the child to technology, and allow them to experience the world in a safe environment (e.g. to perform extraordinary behaviours but without real consequences); they may also have a positive influence on self-esteem (Griffiths, 1997). Other potential benefits suggested are improvement in hand-eye coordination, attention span, and motivation, as well as the development of cognitive skills and the fostering of a sense of mastery, control and achievement. Video games can also help in developing iconic representation and promoting the understanding of scientific simulations, as well as enhancing skills related to forming rules of discovery and to dividing attention (Prensky, 2001). An interesting aspect to consider is how video games challenge the standard model of learning, in which a good learner achieves the goal faster than the others using the 'right' method. Instead, video games reward multiple solutions, the apparent difficulty is viewed as a positive feature, and players set their own standards to judge their performance (Gee, 2003).

On the more social front, it has been argued that computer games may also promote social and family interaction, through cooperation and competition, with games fostering friendships (Griffiths, 1997). In particular, it has been found that children who played more frequently with video games also saw friends outside school more often than those who played less frequently (Colwell et al., 1995, in Griffiths, 1997). A possible key element of this effect is proximity, an essential element of friendship formation (Festinger et al., 1950, cited by Schute and Light, 1978): people are more likely to form friendships with those seen more often. Frequent encounters facilitate the exchange of information, getting to know the other person's interests and beliefs, which is a first step towards relationship building, or at least, an opportunity for social interaction. Indeed, Overton (1997) observes that it is necessary for children to spend time together with certain continuity for friendship to develop, but this alone may not be enough. She considers that children need to have the opportunity to talk, and play in order to get to know each other, e.g. cooperative work affords more opportunities for children to interact than a traditional lecture format. In this line, Crook (1994) highlights the role of the computer as a social catalyst around with several conversations may take place. Overton emphasizes that whichever the activity, it is essential that children perceive it as fun, since this lends them the opportunity of seeing each other at their best, when they are relaxed and having fun: "*The shared experiences of children at play may serve as bonds that develop into friendship.*"

Within this context, the way computer games can foster friendship may be explained by looking at the "by-products" of computer game playing: it generates conversations about the game, the exchange of tricks, getting together to play with the latest version, and so on. In the early times (late 70s), video game playing was a social activity by definition, since games had to be played in the public places who owned the machines. With the developments in broadband access and online gaming, the physical social space has changed: players do not have to meet up to talk about the game, or share tricks or exchange software, they can chat online, post in forums and upload/download all sort of material, but, it still remains a social activity. Interestingly, these activities have lead to the creation of virtual communities in which Huizinga's ideas still hold true: frequently games lead to the creation of a play community after the game is over, with a lasting *"feeling of being apart together sharing something exceptional"* (Huizinga, 1938, p.12).

> *"Video games –like many other games- are inherently social, though, in video games, sometimes the other players are fantasy creatures endowed, by the computer, with artificial intelligence and sometimes they are real people playing out fantasy roles."* (Gee, 2003, p.7).

Despite of Gee (2003) stating that video games are inherently social, Juul (2006) reflects on the fact that video games tend to focus more on the manipulation of objects than on more sophisticated themes such as friendship, love and other human emotions, mostly due to the great difficulty of implementing them in rules. As a natural progression of increased computational power, Gee predicts that even in shooter games talking and interaction among players will become more relevant in the next generation of computer games. Regardless this evolution taking place or not, it is likely that computer games will continue to be a social activity, and as such, an environment for the development of friendship.

In any case, some games are more conducive to interaction than others:

> *"The absorbing interaction between human and computer in simulation gaming can tend to discourage collaborative play. [..] Adventure games, by comparison, have always been more conducive to collaborative playing, because of the stop-and-go nature of the gameplay. When you can't get any further in a game until you solve a puzzle, the more minds the better"* (Friedman, 1995, p. 83).

Another area where computer games have been used successfully is in therapy. Spence (1988) lists some of their applications and benefits:

- *"The arcade games gave an acceptable 'middle' ground for both parties to 'meet' which provided an enjoyable experience that could be shared.*
- *The arcade game provides an opportunity to communicate with young people, often truculent and alienated, in an activity they (as opposed to the adult) find acceptable.*
- *Arcade games were very useful bargaining 'counters' to motivate the child to start work.*
- *The social skills involved in sharing a computer with one or more peers, represents a valuable part of a model for behaviour management using computers.*
- *The use of arcade games can avert violence by relieving tension.*
- *Positive effect on self-esteem is attributable to the ease by which the teacher can prove to the child that he or she can achieve something that others (of higher status) find difficult or cannot even master".*

In addition to the above, videogames are now being used therapeutically to improve concentration in children with attention deficit disorders. It has been demonstrated that they are able to concentrate enough to play videogames for hours on end (Prensky, 2001), although it has been deemed necessary to warn users that games of the 'shoot'em up' type may be detrimental for children with this kind of disorder (Griffiths, 2002).

Part II

2.4 Computers and children with autism

> "'*Just describe me as a computer, then I understand it better'. So said a young man with autism to his mentor, a professor of autism*".
> (Vermeulen, 2001, p. 16).

People with autism relate easily to computers, not only because of their predictability and reliability, but because of the systematic way in which they work. Programming a computer requires mastering the syntax of a language where one word has only one meaning and writing a piece of code that will do exactly what it has been designed to do. In other words, computers work following a set of unambiguous rules and clear instructions.

2.4.1 Why use computers with children with autism?

The use of computers with children with ASD is to some extent justified because they like them and computers seem an age- and socially-appropriate object to feature regularly in their everyday lives. As reported in different surveys, most children like using computers (Condie et al. 2002; Christensen and Knezek, 2003), and children with ASD in particular seem to find computers engaging due to their visual qualities, such as graphics and animation (Lehman, 1998b). People with ASD are primarily visual thinkers (Grandin, 1995), and also have heightened visuo-spatial skills (Mitchell and Ropar, 2004) which may explain why they are attracted to visual-based media. In fact, this has been taken into account when designing a multimedia system which succeeded in improving literacy among children with ASD: the visual qualities were included as a motivator, in the form of animations, and to support learning, by carefully designing animations that matched the learning material (Tjus et al., 2001).

Experts (Murray, 1997; National Autistic Society, 2000; Hardy et. al. 2002), parents (Goncalves, 1999) and people with autism (Grandin, 2000; Dekker, 1999) all point out the positive effect that computers are having in the lives of children and adults with ASD and their families. Something that the whole family can share and spend time together doing, such as computer game playing, can be very rewarding for those involved (Murray, 1997), helping to relieve the stress arising from the demands of living with a person with ASD (in the case of the family), and of being frequently misunderstood (in the case of the individual with ASD). In other words, computers are a special interest that can be shared easily with peers or adults, providing a common activity around which to build a relationship (Murray, 1997; Vermeulen, 2001).

Some computer-based tools may facilitate the creation of visual material, such as a multimedia journal, that help people with ASD communicate their needs and experiences, thus, increasing their autonomy and independence (Hansen, 2000). In the case of high functioning people with ASD, the internet has facilitated the creation of very active online communities where members can chat, email, or post in forums, among others (Dekker, 1996), and they can develop their professional careers in computer related jobs (Grandin, 2000).

Not only are computers widely available, they are also perceived as fun by children (see survey by Condie et al. 2002). While, in general, children enjoy using computers, they do not enjoy them at school, where their use is very limited and restricted to drill and practice tasks and word processing (Mumtaz, 2001). If the use of computers at school gave more control to the children, with challenging programs, which are the features they like (Wishart, 1990), then, children would probably enjoy them at school too. In the meantime, children use computers more frequently at home, where they can have more time to explore different software as well as play computer games, than at school, (Mumtaz, 2001). Interestingly, access to a computer at home is one of the factors influencing children's positive attitudes towards computers (Martin, 1991), both in terms of enjoyment and perceived importance (Knezek et al., 1994). It seems that the most frequent experience of computers takes place at home and is one of game playing, a fun activity, which may shape children's general attitude towards computers, not merely computer games, and an association to 'fun':

"I think that computers are really good to use because they are fun and can help us learn".
Paige, 12, Northampton.

"I think that computers are super and should be used in schools more!"
Alicia, 12, Manchester.

(Quotes from BBC-C web site, 2006)

During the course of the research described in this thesis there was a constant reference to how much children with ASD enjoyed using computers by the teachers, parents and professionals contacted. In the words of the mother of a three year old boy with autism:

> *"We found Tony liked best cause and effect toys and in particular those small, dedicated computers for children (e.g. Vtech IQ builders). Amazed by how well Tony worked through the programmes and delighted to discover in therapy how he had learnt number, letters and spellings, we soon moved on to computer software for our PC."* Mendham, (2006).

Lehman (1998b) also refers to reports by parents and professionals which frequently *"indicate a preference for computer activity over other sorts of play and the kind of intense and sustained attention* *during interaction that is a prerequisite for learning"*. Children with ASD enjoy the fact that computers afford the possibility of easily repeating their favourite actions (Lehman, 1998a). On the other hand, computers can take the burden of dull tasks (e.g. formatting text, spell check), freeing the child to focus on other more demanding tasks (e.g. writing text), (Hardy et al., 2002). The beautiful graphs and nice presentations easily achieved by means of word processors and other software can be very motivating for those with motor difficulties whose handwriting is frustratingly poor (Grandin, 2000).

From a less practical point of view, and looking at the main psychological theories, it is also possible to find more reasons why children and adults with ASD may feel comfortable around computers. Looking at Baron-Cohen's theory of mind (see Ch.1, p.12), when compared with guessing what another person may be thinking, computers seem easy to understand: human-computer communication is direct, clear and literal, e.g. if the user presses the right button, the computer may ask "do you want to log out?", to which the user can respond "yes" or "no", without any regard to the computer's feelings, which do not exist. After trying to deal with a world full of sophisticated social rules, not having to worry about those for a little while can be quite relaxing for a person with ASD.

The executive functioning theory (Happe, 1994) explained difficulties in problem-solving and planning, and computers may help in a number of ways: there are tools that help organise information to facilitate its analysis, e.g. spreadsheets, other tools assist with planning by recording the events, e.g. diaries; and, finally, some computer-based activities, such as programming, require planning, thus may help in developing this skill. Furthermore, features that evidence weak central coherence (Frith, 2003) such as need for sameness, restricted interests and difficulty with relevance of information may be helped by computers: they are predictable objects that will respond always the same way to the same actions (need for sameness), computers can be a specific interest by themselves but also afford the opportunity to research and pursue other interests, by means of specific software or the internet, and, the focus on the screen and configurable output may aid with selecting one piece of information at a time to focus on.

Computers are also a powerful and flexible tool that can be used for teaching academic skills and other aspects within the National Curriculum as well as addressing the triad of impairments that characterise autism (Moore et al., 1999; Murray, 1997). In the area of communication skills, word processors and speech recognition software are widely used, but the use of video simulations to teach about body language and facial expressions also has great potential (Moore et al., 1999). Hardy et al. (2002) add that computers allow us to slow down some interactions, by adjusting settings and repeating a sequence, with some programs encouraging vocalisations, and with children with ASD being keener to communicate with their peers to gain their turn. They further suggest that some programs used to aid communication may improve on children's understanding of words by aiding memory through the use of visual symbols. It is also possible to use standard software with a communicative purpose:

> *"Tony is an able visual learner but with very little language so we deliberately chose software where it was necessary for Tony to listen in order to respond to the computer."* (Mendham, 2006).

On the other hand, the impairment in imagination in autism which results from rigidity of thought may be helped by interactive tools that allow the user to create his/her own multimedia material, and simulations may help to make sense of sequential processes (Moore et al., 1999). The fact that programs are clearly structured with beginnings, endings, sequences and options makes them predictable and easy to make sense of, transforming a learning experience filled with anxiety and frustration into a more positive one for children with learning difficulties (Hardy et al., 2002): when children face a non-judgemental 'teacher' and are in control of the pace of the experience they can cope with learning tasks previously very challenging (Murray, 1997).

With respect to social skills, Murray (1997) highlights the need to build a therapeutic relationship around the computer in which motivation to communicate is increased while social demands are minimised. The environment is created by the predictability, controllability, clear-cut conditions, restricted stimuli, safe error-making and non-threatening qualities of computers, while the application allows the child and adult to communicate verbally and non-verbally, as well as to develop turn taking skills (Murray and Lesser, 1999; Hardy, 2002).

What makes computers non-threatening for those with autism is the fact that the focus of attention is the screen, which acts as a third party in an interaction, placing minimal pressure on the child (Murray, 1997). In addition, the computer screen contains all the information necessary for the task at hand, which helps filtering the irrelevant stimuli from the surroundings (Burack, 1994), something children with ASD have difficulties with, which may explain why these children may tolerate a sensory input while at the computer than in other contexts (NAS, 2000). This allows computers to provide a framework for adapted communication in which people who can not otherwise cope with the demands of a standard communication process may become more able communicators.

2.4.2 Computer technologies to address social interaction difficulties in children with autism

Moore et al. (1999) proposed the design of a drill and practice computer assisted learning system for those with autism which would teach some social 'rules of thumb' that could be useful in real life situations, such as how to dress formally or informally. They also suggested the development of computer-based simulated role-play activities, and the use of Virtual Reality to facilitate generalisation to real life situations. In recent years, many of these proposed applications have been developed, together with others that make use of different technologies such as Artificial Intelligence, Robotics, or the Internet. In addition, approaches such as bubble dialogue software and navigational agents displaying a range of emotional responses have also been explored as a means of teaching theory of mind.

Computer Aided Learning (CAL)

In the area of educational software designed specifically for people with ASD, the Computer Aided Learning (CAL) systems developed at Leeds Metropolitan University are particularly worthy of note. Current prototypes include a system addressing social skills by presenting a video scene of a school canteen and asking for the appropriate behaviour to continue the action then offering follow up videos to show the consequences of different options. Another system requires users to identify facial expressions and body language and a third prototype addresses the theory of mind deficits (see Chapter 1, section 1.1.9) by playing videos showing various interaction between two children and asking what they might be feeling (Moore et al., 1999). The group is now in an initial trial exploring Collaborative Virtual Environments through the use of avatar[1] representation of emotions, an environment in which people with ASD seemed to be able to recognise emotions and control them appropriately (Cheng, Moore, McGrath and Fan, 2005) - see also below.

Other applications created specifically to teach social skills to people with ASD are also commercially available. The application "Fun with Feelings" (DigiSoft, 2005), for example, makes use of video clips and repetition to allow the child to identify the facial and body features of up to twenty emotions. Much more sophisticated is the "Mindreading: The Interactive Guide to Emotions" package, which presents more than 400 emotions with video clips of six different people, including stories to provide a context, three types of virtual helpers and six levels of complexity (Baron-Cohen, 2004). The application,

[1] An avatar is a representation of a user on a virtual environment. It could take the form, among others, of a symbol, a face, or a full-bodied character.

developed at Cambridge University under the supervision of Simon Baron-Cohen, can be used by adults and by children from the age of four.

Virtual Reality

Strickland, Marcus, Mesibov and Hogan (1996) carried out a small case study using Virtual Reality with autistic children. They report on two children with autism and prior experience with computers, aged 7-9. They found that they accepted the Virtual Reality helmets, immersed themselves in the different virtual scenes (e.g. walking in the street), identified different objects and moved their bodies according to the scene. The study highlighted VR as a technology that can be successfully used by children with autism.

More recently, other Virtual Reality systems for use with those with autism have been under development by a research team at the University of Nottingham (VIRART) and another at the University of Valencia (Spain), co-ordinated by Gerardo Herrera. In both systems, the actions taking place in the virtual world can be controlled by a therapist, allowing the preparation of individually-tailored interactive sessions.

The Nottingham project, AS Interactive, has developed and tested a virtual reality environment to aid the learning of social skills. The system offers two everyday scenarios, a café and a bus, within which the users can practice some social rules such as appropriate use of personal space (Cobb, Kerr and Glover, 2001). In order to teach social rules, it has different levels of difficulty, e.g. an empty bus (all seats are available), a partly-filled bus (some double seats with seats beside people available), or no double seats available. The system also provides a means of obtaining help as well as feedback on performance on the task. AS Interactive has been used to evaluate adherence to social conventions in virtual environments, finding that individuals with ASD, low verbal ability and weak executive ability needed more support to remain on task (Parsons, Mitchell and Leonard, 2005).

At the same time, Herrera et al. (2005) started up the INMER project as an immersive system which provides a cognitive and social ability rehabilitation tool. In their initial trials they tested the use of a Virtual Reality helmet that children with autism seemed to accept well (Herrera, 2000). This, however, had to be withdrawn from the intervention design due to the high cost of the device, and a standard screen version of their virtual reality application was developed. Having obtained initially positive results with respect to the development of symbolic play, another aim of their trials, still ongoing, is to compare the outcomes of the VR system with those using a more traditional teaching approach. The project is using a step-by-step teaching style, including functional use of objects, functional play, imaginary play, transformation of objects, and imaginary transformations. Some of the limitations of the current version of the system are the lack of opportunities to develop creativity and social skills.

Artificial Intelligence

In the field of Artificial Intelligence, Lehman (1998a) developed a system called Simone Says to support language acquisition at an early stage, combining speech recognition, natural language understanding, animation, and student modelling. The system, aimed at non-mute children with autism, was designed to support a core vocabulary of 100-200 words, with basic semantics and syntax, simple pragmatics, joint attention, turn-taking and simple conversational repair. The system first displays a simple graphical stimulus (a short animation) to prompt conversation, and then requires a meaningful verbal response from the child, which may be modelled for him automatically, followed by a related animation sequence, which functions as a reward. These animations were designed following three principles: make every interaction rewarding, motivate active involvement, and balance realism with fun. The critical feature of Simone Says is its ability to gradually demand more of the child in terms of the level of sophistication required to consider a verbal response meaningful enough to obtain the reward.

Within the same area, a Negotiation Tutor prototype has been built to assess the potential of Intelligent Tutoring Systems for aiding interactions in a basic negotiation situation (Wu and Pino, 2001). The Negotiation Tutor provides a context in which two people, a child with ASD and a socially skilful partner, decide on what game to play together. The system could be installed as a gateway to access the computer games in the machine the child uses. In order to design the tutor, the social skills involved in the task are analysed and broken down into programmable steps. The interface was designed to maximise the use of visual information and to minimise verbal language and distractions. The system challenges the child with ASD in a range of ways:

- it requires decision-making skills to decide on which game to play.
- the child needs to recognise and externalise his feelings in order to rate a game, using a thermometer-like image, as well as being required to recognise the feelings of others.
- the system mediates the child's attempts to persuade the Partner into playing his chosen game.

Being exposed visually to the different levels at which both parties would want to play their chosen game was thought to provide an insight into the mind of the other and the opportunity to change a choice considering the partner's opinions. The development of the prototype required an analysis of the process of negotiation and a decomposition into small tasks that generated a series of rules that could be taught outside the computer context. This highlights the potential of computers, and specifically programming, to act as a framework for developing instructional material with social content for people with autism (see report in Appendix A).

Robotics

In 1976 Weir and Emmanuel published a single case study of a seven year old child with autism using a turtle robot programmed in LOGO. The child was withdrawn, avoided eye contact and did not make spontaneous speech. The turtle could be directed to move in any direction on the floor and had an embedded pen that could be lifted or lowered in order to make marks on the floor (covered with paper), allowing the child to produce drawings if desired. During seven sessions of one hour spread over six weeks, the child was filmed while manipulating the turtle robot via a simplified keyboard, under adult supervision. Apart from the child becoming more interactive as the sessions passed, Weir and Emmanuel noticed that he started to vocalise his thoughts spontaneously (as these related to the task), and to identify himself with the turtle, e.g. after pushing the button 'Pen Up', he pointed as his belly button, and stood up. They also observed that the child shifted between two modes of behaviours which they labelled 'passive pupil', characterised by lack of eye contact, high pitched voice and lack of spontaneous activity, and 'emotionally committed', described as self-initiating and spontaneous behaviour. The researchers observed that the change from emotionally committed to passive pupil role took place in a number of circumstances, when:

- not being allowed to be a free agent of his activity.
- not seeing the relevance of a given task.
- not understanding what was expected of him in a task.
- not being confident with his ability to complete a task.

Despite the encouraging results, the study of Weir and Emmanuel were not immediately followed up by any other research teams. More recently, however, the Aurora Project, lead by Kristine Dautenhahn, has explored the possibilities of using robots as social mediators in autism. The project allows autistic children to learn to interact with their environment by means of a mobile robot which is inherently more predictable and controllable than human models and can be used as a means of introducing the child to social interactions (Dautenhahn, 1998).

The robot used in the initial trials was autonomous and mobile, which meant that it was not controlled by an experimenter but programmed to respond to the child. Apart from being able to produce words and simple phrases, the robot was equipped with touch and video sensors that allowed it to assess where the child and other obstacles were, in order to react to the child's actions. During the sessions, the child was allowed to interact with the robot in any position and type of action, making it a playful and unstructured experience. Children developed 'chasing games' and other types of interaction, e.g. reaching out to touch the robot could cause the robot to approach the child. The first trials with children aged 8-12 showed that they enjoyed the interaction with the robot and that this provided a focus of shared attention not only in child-child interactions but also in child-teacher and child-experimenter pairings (Werry, Dautenhahn, Ogden and Harwin, 2001).

Within the Aurora project, another study used an actor who, while behaving in a similar manner, presented himself in two roles, as a Stranger and as a Theatrical Robot, during interactive sessions with four children with autism, aged 5-10. It is often reported that children with autism tend to ignore strangers (Hobson, 2002, cited by Robins, Dautenhahn, and Dubowski, 2004) and prefer dolls with a simple appearance rather than those depicting very human features (Ferrara and Hill, 1980, cited by Robins, Dautenhahn, and Dubowski, 2004). Interestingly, the children behaved more socially and proactively with the Theatrical Robot (Robins, Dautenhahn, and Dubowski, 2004). This finding seems to support the use of robots with limited features that can be increased later on to become more human-like in appearance. It also opens up the possibility of developing interaction skills that would never take place if the partner was a stranger, for instance, extending interactions to include other people. Furthermore, it suggests a technology-free alternative to robotics in autism therapy.

The work of this research group has shown the need for longitudinal studies in this area. Short term studies are compromised by the variability that changes in the children's routine may often introduce. Longitudinal studies allow scope for demonstrating the development of social skills over time, as well as for evaluating their post-training longevity (Robins, Dautenhahn, Boekhorst and Billard, 2004).

In a recent study, Robins, Dautenhahn, Boekhorst and Billard (2005) explored both robot-human and human-human interactions with the use of a small robotic doll. Four children aged 5-10 years took part in a series of trials carried out over several months, with each child completing an average of 9 trials, with an average duration of 3 minutes. The robot had a simple appearance and acted in two modes: as a 'dancing doll', moving body parts to the rhythm of music according to a pre-determined program, and as a 'puppet', manipulated by the experimenter from a computer placed near by. The early trials involved the dancing doll mode, to attract the child's attention; then the setup changed to showing the child how he or she could imitate the moves of the robot, and during the last stage, the child was free to interact in whichever form he desired, with the experimenter handling the reactions of the robot. The analysis of the video recordings showed that there was an increase in basic social interaction, both with the robot and the adults involved, i.e. the experimenter; in some cases where children were paired, they also used the robot as a mediator, as an object of shared attention.

More general computer-based approaches

There are other ways of using computers that are less demanding in terms of technological power and sophistication. Simple computer games can teach turn taking, a basic communication skill, and can also provide a social situation in which the child plays a game with somebody, talks about the game, etc. It has also been demonstrated that the use of computers can enhance awareness of self and others, increase co-operation and promote a significant desire to 'show' (Murray and Lesser, 1999). For the Spanish association PAUTA (Psicopedagogía del Autismo y Trastornos Asociados/Psychopedagogy of Autism and Associated Disorders), the computer is seen as just one more element of the classroom. They have developed simple programs for teaching specific skills by using simple software which can be learnt in a few hours and encouraging teachers to use computers imaginatively (Perez, 2000).

Everyday software can also be used to encourage sharing, 'showing' and social interaction. Word processors, graphic programs and simple authoring tools are available at very low cost and allow the person with autism to produce text or visual material to share with others or can aid their memory when trying to communicate their experiences (Hansen, 2000, Murray and Lesser, 1999). Gray (2000) proposes sitting side by side at the computer to have a text-based conversation, whereas Rajendran and Mitchell (2000) propose that Bubble Dialogue, a computer application for role-playing, can be used as a tool to improve social understanding in those with Asperger syndrome. Although the initial study with Bubble Dialogue did not show any clear improvement in this area, it did have a positive effect on the participants executive function scores. The program is currently being used to investigate social understanding by looking at how individuals with autism apply social rules as opposed to simply reflecting on them (Rajendran, Mitchell and Rickards, 2005).

Internet

> "*The Internet is for many high functioning autistics what sign language is for the deaf.*"
> (Dekker, 1999)

The internet offers several options for expression and communication that require less processing of information than that demanded in the understanding of intonation and facial expression (Rajendran and Mitchell, 2000). In one-to-one communication, email presents minimal demands, with unlimited time to understand a message and to prepare a response. Then there is instant messaging or chat that brings in real time text-based conversation, and can be enhanced with the addition of video (using webcams) and audio, making it more of a face-to-face conversation but without the requirement for physical proximity. In a more open and less controlled setting, there is the option of setting up a website where the communication is unidirectional, or includes message boards or forums, to allow users to post information and comments in a common space, with the same off-line thinking time that email allows. Videoconferencing with multiple partners is the most demanding of all forms and is very close to a real social situation, and yet is still mediated by the computer.

Mobile technology

Although not a yet a fully operational system, it is worth mentioning the development of a prototype of an 'emotional hearing aid', an assistive tool designed to provide emotional understanding from video, for people with Asperger's syndrome (El Kaliouby and Robinson, 2004). The system consists of a commercial cam-corder, a personal digital assistant (PDA), and an earpiece speaker. The camera records video signals of a potential communicator which are processed by the PDA, which provides instructions about the appropriate course of action through the speaker. Once developed, the system would function similarly to a hearing aid, facilitating the user in the interpretation of facial expressions.

Herrera et al. (2003) are also using PDAs which include a GPS device to indicate to autistic users where they are or where to find what they need. Its main aim is to provide predictability in the environment, with the aim of reducing several anxiety-related behaviours.

2.4.3 Overview: Using computer games as a medium for social interaction with children with autism

Children with autism find the real world exceptionally demanding. They may have not only heightened sensory sensitivity which often results in sensory overload, but may also have to deal with unwritten social rules that they cannot make sense of. This is potentially very stressful and often generates high levels of anxiety, which in turn leads to a variety of maladaptive responses. In order to cope, some children display challenging behaviours, others become more isolated, while others seek solutions which may exacerbate the dependence on repetition and routine. In the general learning environment, a social situation which is already highly negatively charged for them, computers may take some of this pressure away and relieve stress as they offer the user control over the learning pace and place, allowing mistakes to happen in private, and acting as a patient and consistent tutor (Condry and Keith, 1983).

Rawlins (1995, cited by Griffiths, 2001) reports that children with pervasive developmental delay or atypical autism respond well to the use of computer technology because of their isolation, but that the use of the internet may be useful to augment and aid their social interaction. This medium provides the opportunity for online game play, including interactive video games, where not only the player's character is interacting with other characters, but players can simultaneously communicate in order to exchange information, discuss strategies, or talk about anything else. However, these games can be played off-line and individually as well.

For Hardy et al. (2002):

> *"Computer games can develop the idea of interaction – initially between the child and the computer but gradually extending this play to another pupil"* (p23).

They explain that playing chess with a computer can later be transferred to playing the same game with a real person. Murray (1997) likewise suggests the use of two-person video games can foster awareness of others through the cause and effects that each player generates, with the added benefits of this being an activity which invites turn-taking and also attracts social acceptance in peer group terms.

Demarest (2000) reports on a range of other benefits which can be obtained from using video games by autistic children. Skills which may be enhanced include:

- language: discussing, sharing, answering questions, following and giving directions
- basic maths and reading skills: counting items, reading basic instructions
- social skills: having an interest that is popular with other children makes talking and playing together so much easier.

While the potential benefits of video games for children with autism may be clear, the type of games they may find enjoyable could be different to those of typically developing children. Lehman (1998b) found that typically developing children enjoyed randomness in the unfolding of a game and its layout, consider competition a motivator and appreciate the possibility of cooperation and multiple levels. In contrast, children with ASD enjoyed the visual effects and richness of detail in games more, and the combination of text and audio information. They did not show any clear preferences for very subject-specific or factual material, nor for fantasy or role-play games, although they seemed more attracted to educational games that required speed in the response. Both groups of children in Lehman's study liked music and sound effects, the presence of animated character guides and child-controlled games. Given that there is sometimes a concern that the use of computers with children with autism may add to their social isolation, it is worth pointing out that, despite indicating a preference for playing with others, both groups enjoyed the use of computers mainly as an individual activity.

In summary, computer games provide a stress-free environment which is motivational, allows the child to be in control and provides a common interest with the child's peer group. As a consequence, a child with autism may have the opportunity to interact with other children in this type of social setting, whilst gaining in self-esteem and status within the peer group from mastering a game. Learning to play a computer game may act to build a bridge to a social world for such children, a possibility explored further in later chapters of this thesis.

Chapter 3: Exploring the context of autism-specific education: computer use in the field

This chapter explores the extent and nature of computer use with children with autism in educational settings. It reports on findings from a small scale survey among special needs educators which gathered opinions on the potential of computers for enhancing social interaction in this group of children. The information derived from this survey is complemented by data from a small set of interviews with professionals currently using computers in their work with children with autism. A second small interview study with a multidisciplinary group of volunteers participating in a social interaction project explored the techniques they considered effective in fostering social exchanges with children in the project. Informed by this preliminary work, the design of a prototype of a lego robot as a potential mediator for interaction is presented. The design of the prototype, however, highlighted the problem of using open ended applications to explore the potential role of computer use with children with ASD as these left some very basic questions unanswered. This lead to a shift in focus to examining the potential of more basic, low cost software.

3.1 Questionnaire study: Teachers' opinions on the use of computers with ASD children

3.1.1 Introduction

Previous chapters have highlighted the importance of early intervention and the potential of computers for enhancing social interaction in children with ASD. They have also provided information on the level of access of computers in British schools and the uses to which they are typically put. The purpose of this study was to gather teachers' opinions specifically about the use of computers with people with autism. Their views influence the way they use technology and therefore are likely to define the sort of access people with autism will have, having a direct impact on how they may or may not benefit from their use.

Different questions arise. Do children with ASD have access to computers? Are teachers aware of the different possibilities for computer use? Are they willing to use them with children with ASD? What are the differences in access and attitudes between Scotland, part of a technologically advanced country, and a community at the lower end of technical progress but aspiring to keep up with European standards, the Canary Islands (my home country)?

3.1.2 Access and attitudes towards computers

Chapter 2 presented data showing that computer access in British schools had risen between 1998 and 2004, from a ratio of 1 computer for 17.6 pupils to 1:7.5 in primary schools, 1:8.7 to 1: 4.9 in secondary schools, and 1:4.7 to 1:3.0 in special schools (Prior and Hall, 2004).

Survey based data were not available for the Canary Islands but provision is widely recognised to be poor by teachers and other professionals working in school settings. However, a new program called the Medusa Project is funding the introduction of computer networks throughout the public schools (primary and secondary), aiming to network them so they have access to the internet, can share resources and videoconference with other schools, and streamline administration (La Opinion, 2003). The project was launched in 2002 and so far has involved 94 secondary schools, 55 professional (vocational) schools and 63 primary schools; these now host a total of 97 servers, 4,995 computers and 637 printers. By 2004, all the secondary schools and another 739 primary schools (with 15.000 new computers) were scheduled to have been included in the network, and by 2006 all centres, 1,536 (350,000 students) were to be connected (El Dia, 2003). The process has been slowed down, however, and applications from primary schools were still being processed during 2005 (Boletin Oficial de Canarias, 2005). Although there was not data available about computer to pupil ratio, a visit to a secondary school involved in the Medusa project allowed to observe a ratio of 1:20 (Pino, 2006), still far behind of the ratio in Scotland.

A Scotland-wide survey (Williams et al. 1998) shows that teachers' use of ICT is an indicator of their knowledge and skills, but that there is a gap between this and the impact of ICT in the classrooms, due mainly to a lack of confidence in introducing them as a teaching media. The study took place between October 1997 and April 1998, with an initial survey of primary and secondary teachers followed by a number of interviews. This two-phase approach took advantage of the high number of responses that can be obtained in a short time by means of questionnaires, giving a broad picture, with the depth and more rich descriptions that can be obtained through interviews.

The aim of the study was to investigate teachers' needs with respect to knowledge and skills in ICT and to suggest actions targeted at improving the quality and quantity of effective use of ICT in Scottish Schools. One of the key findings was that there was not a clear relationship between ICT use and attitude: those who used ICT at home also used it more at school, but this was correlated with a more positive attitude only in the primary teachers. At secondary level, the attitudes of teachers of different subjects were mixed but overall positive, with most being willing to undertake training if it was designed to meet their practical classroom needs.

In sum, both children and teachers in mainstream education seem to have broad access to computers. Initiatives are being taken to ensure that this access increases in future and that all students benefit from it. The attitudes and knowledge of the teachers and other professionals involved in therapy and in educational interventions for children with autism have not yet been reported in the literature reviewed in earlier chapters, a gap which the following studies aimed to address.

3.1.3 Methodology

This study was designed to investigate teachers' and trainee teachers' attitudes towards the use of computers with children with ASD in both Scotland and the Canary Isles. In order to gather an initial overview of the situation, a questionnaire was devised to enable the collection of the opinions of as many subjects as possible in a short period of time.

The questionnaire explored the following questions: What use of computers do teachers think might be of benefit for people with ASD? How should computer use be best managed? Do teachers' perspective and attitude towards computers differ according to level of experience with people with ASD or according to their level of experience of using computers with people with ASD computers? (see Appendix B).

The set of computer applications selected for evaluation was drawn from the educational and ICT literature and sorted from those most commonly used in educational contexts to those least used: word processing, speech recognition, pointing devices, communication software, educational software (academic skills), computer games, robotic toys, electronic toys, internet browser, graphic design software, programming, and email (UK respondents only). Respondents had to evaluate whether these applications/devices were beneficial, detrimental or neither, using a 5-point scale (very detrimental to very beneficial). An equivalent rating scale, with the central value the neutral one, was also used to assess attitudes towards computers.

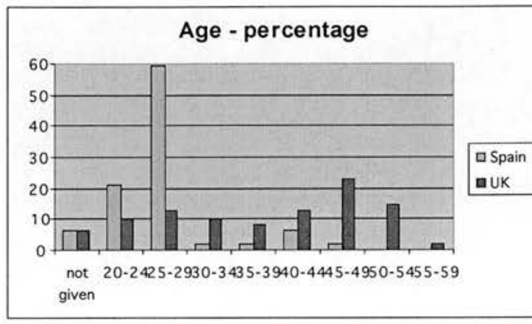
3.1.4 Subjects and procedure

A questionnaire was distributed to two different groups of teachers and professionals. The first group consisted of 47 students enrolled on a part-time postgraduate course in Special Educational Needs (SEN) in the Canary Islands (Spain). They had attended a module in Technology and SEN and were undertaking a module in autism at the time the questionnaires were filled in. The second group consisted of 48 teachers and allied professionals enrolled on part-time postgraduate courses in either SEN (with a module in autism) or specialising in autism.

Respondents age

As it can be seen in Figure 3.1, the majority of total respondents (more than 50%) were under thirty years old, which were clear differences between the Spanish and British groups.

Figure 3.1 Age range percentages.



Age

In the former, around 80% of participants were under thirty, whereas in the latter, age was more evenly distributed, but with a concentration around the 40-54 age range (38%). This may be explained by the fact that in Spain it is very common to undertake postgraduate education straight after undergraduate studies, as a means to improving job prospects (the majority of the participants are funding themselves), whereas in the UK courses, local authorities may encourage or even fund their employees to go into further education at later stages in their careers. These differences in modal age are obviously likely to impact on amount of experience with children with autism, and this is discussed later. It is reasonable to assume that a shorter length of time provides fewer opportunities to gain experience with autism unless a professional is working in a specialist environment.

Gender

The great majority of respondents were female (around 90%, see Table 3.1), which seems to confirm the higher presence of women in the educational sector in general and the SEN sector in particular. Both groups showed this strong gender bias, with similar proportions of 95% of respondents in the UK group being female and 85% in the Spanish group.

Table 3.1 Respondents gender.

Gender	N	%
Not given	1	1.1
Male	8	8.4
Female	86	90.5
Total	95	100

Occupation

The majority of respondents (60%) were in the educational sector, including primary, secondary, and special education teachers, auxiliary staff and various more specific roles (e.g. career guidance, social educator). A high proportion of the UK group were also from this sector (73% versus 46%), although a significant number of Spanish participants did not answer this question (32%), making it very difficult to compare the two groups according to occupation (see Table 3.2).

Table 3.2 Respondents occupation.

Occupation	Spain	Spain %	UK	UK%	Total	Total %
Teaching	22	46.8	35	72.9	57	60
Others	10	21.3	13	27.1	23	24.2
Not given	15	31.9	-	-	15	15.8
Total respondents	47	100	48	100	95	100

Experience with ASD

Level of experience was defined by looking at the number of children with ASD that each respondent had had contact with and the length of time over which this contact had taken place. It was recognised that a small number of cases over a long period of time might provide an understanding of the condition equivalent (although different) to experience of a large number of cases over a short period of time.

Minimal experience was defined as experience of one child over less than a year; *little* experience as up to three children but over less than a year; *moderate* experience as 4-5 children over 1 to 2 years (or less cases for longer, plus a few more for a shorter period); *much* experience as 6-10 children for 6 months up to 5 years (with equivalence as before); and *great* experience as more than 10 children for 1 or more years (or 6-10 for more than 5 years).

As Table 3.3 (over) shows, the sample had a good proportion of respondents with extensive experience with people with ASD (much 21% plus great 13%, total 34%), but also included people with no experience at all (36%). The main difference here is between the two countries, with twice as many totally inexperienced respondents in the Spanish group (23) as in the British group (11), and three times more with only minimal or little ASD experience (15 to 5). In addition, the British group had 27 respondents within the high end of experience, versus 5 from the Spanish group.

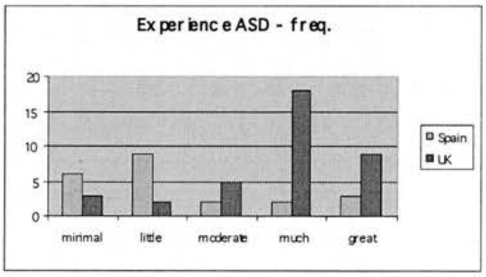
Table 3.3 Responses about experience with ASD.				
	Frequencies		%	
Experience	Spain	UK	Spain	UK
No experience	23	11	48,9	22,9
Minimal	6	3	12,8	6,3
Little	9	2	19,1	4,2
Moderate	2	5	4,3	10,4
Much	2	18	4,3	37,5
Great	3	9	6,4	18,8
Total	47	48	100	100

Table 3.4 and Figure 3.2 show only the respondents who had experience with children with ASD (64%). Only 23% of the Spanish respondents had much or great experience with autism, contrasting with 73% of the British group.

Table 3.4 Experience with children with ASD.

	Frequencies		%		
Experience	Spain	UK	Spain	UK	Total
Minimal	6	3	27.3	8.1	15.2
Little	9	2	40.9	5.4	18.6
Moderate	2	5	9.1	13.51	11.9
Much	2	18	9.1	48.6	33.9
Great	3	9	13.6	24.3	20.3
Total	22	37	100	100	100

Figure 3.2 Experience with children with ASD.



Experience

This reveals a clear difference in the general level of experience in the two regions, but can be explained in two ways. First of all, part of the British group was recruited from a postgraduate course in autism, and it therefore seems reasonable to assume that those attracted to such courses are more likely than those who choose more general SEN courses to have this specific professional interest and to have been in contact or intend to be with people with autism.

A second reason for this difference may lie in the fact that in the UK there are more specialist units for children with ASD and communication disorders, as well as residential schools specifically for children with autism. In Spain there are only a very few residential centres and in the Canary Islands those who need residential care have to attend a general special needs centre. There is also less awareness of autism in Spain and getting a diagnosis is more difficult, which the result that contact with children with ASD is less likely that in the UK.

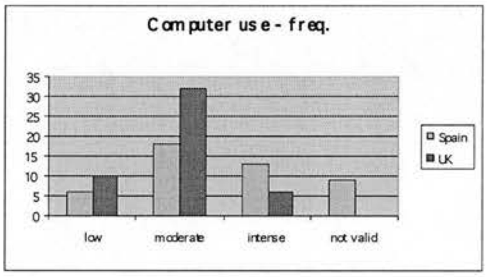
Computer use

Computer use was defined by frequency (rarely, monthly, weekly or daily) and length of session (<1 hour, 1-2, 2-3, 3-4 and >4 hours). Respondents were classified into levels of use: *rare* (used rarely, for any length of time, or monthly for less than 1 hour), *low* (1 hour or more monthly, or weekly for less than 1 hour), *moderate* (weekly for 1-4 hours or daily for less than 2 hours), or *intense* (daily for 2 hours or more, or weekly for more than 4 hours).

Table 3.5 Computer experience with children with ASD.

	Frequencies		%	
	Spain	UK	Spain	UK
Low	6	10	12,8	20,8
Moderate	18	32	38,3	66,7
Intense	13	6	27,7	12,5
Not valid	9	-	19,1	-
Total	46	48	97,9	100,0

Figure 3.3 Computer use.



Computer use

As Table 3.5 and Figure 3.3 show, the majority of respondents used computers regularly (moderately or intensely), with the British group clustering in the moderate range and the Spanish group more widely spread. Given that the classification criteria were somewhat arbitrary, however, these comparisons are illustrative rather than conclusive, demonstrating mainly that computers are used regularly in both samples.

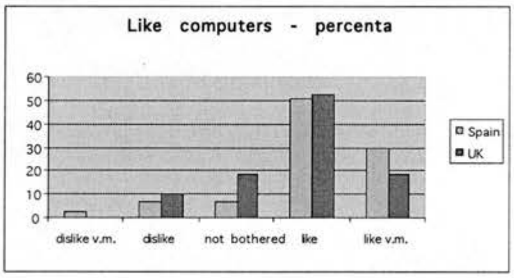
Attitudes towards computers

The majority of respondents (76%) reported that they liked using computers and with just under 10% reporting that they did not like using them (see Table 3.6). Both national groups display a similar profile, with a slightly more positive attitude in the Spanish group (81%) than the British (71%). The small number of negative responses makes it hard to assess whether this factor has any influence on their opinions in relation to more specific questions about computers and computer use.

Table 3.6 Attitudes towards computers.

	Frequencies		%	
	Spain	UK	Spain	UK
Dislike v.m.	1	-	2.1	-
Dislike	3	5	6.4	10.4
Not bothered	3	9	6.4	18.8
Like	24	25	51.1	52.1
Like v.m.	14	9	29.8	18.8
Total	45	48	95.7	100

Figure 3.4 Attitudes towards computers.



Attitudes

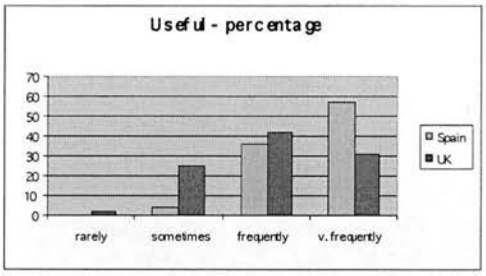
Views on usefulness of computers

The vast majority (84%) of respondents considered computers to be useful (see Table 3.7, Fig. 3.5, below). The Spanish group generally had a more positive view (96%) than the British group (71%). It would be hard to explain this difference solely by reference to level of access to computer use. A possible explanation might be that computer use is a more recent development in Spain than in the UK, and the potential benefits of computers still outweigh their potential disadvantages, whereas in the UK the novelty may have worn for users and they may now expect a more efficient tool. However there was nothing in the questionnaire that could enable these national differences to be explored more deeply and explained.

Table 3.7 Views on usefulness of computers.

	Frequencies		%	
	Spain	UK	Spain	UK
Rarely	-	1	-	2.1
Sometimes	2	12	4.3	25.0
Frequently	17	20	36.2	41.7
V. frequently	27	15	57.4	31.3
Total	46	48	97.9	100

Figure 3.5 Views in usefulness of computers.



Opinion of usefulness

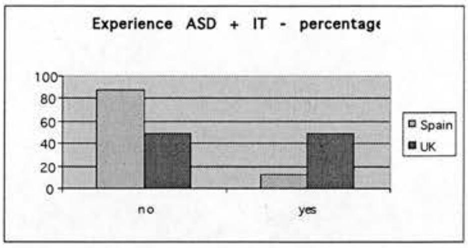
Experience of using IT with children with ASD

Table 3.8 and Fig. 3.6 (below) show that a third of respondents had used computers with children with ASD and it would seem reasonable to think that their opinions might be better informed than those of the rest of the sample. National differences in this respect were very marked: half of the British group has had experience of using computers with children with autism, whereas only an eighth of the Spanish group. However, if we look at these numbers based on the respondents that have experience with ASD, then those with experience of IT with children with ASD become a 25% in the Spanish group, and 65% in the British group.

Table 3.8 Experience of IT + children ASD.

	Frequencies		%	
	Spain	UK	Spain	UK
No	41	24	87.2	50
Yes	6	24	12.8	50
Total	47	48	100	100

Figure 3.6 Experience of IT + children ASD.



Experience

This may be surprising when looking at computer use, since both groups seem to have a similar level of use of computers. The explanation could be quite simple: the use referred to is personal use, and the computer could belong to the school or to the respondent. On the other hand, computer use with children with ASD will depend greatly on the presence of computers in the school or professional environment where respondents work with the children. In UK, and in the Scottish schools visited there, there is at least one computer in the classroom, even at primary level, and the number tends to be higher in special units. The typical scenario in Spain is of a computer lab, where there is one computer per child, used predominantly for IT classes. It seems therefore that the Scottish setting is an environment in which the use of computers may occur more easily and frequently than in the Spanish educational system.

3.1.5 Views on computer use with children with ASD

Should children with ASD use computers?

The majority of respondents (93%) agreed that children with ASD should use computers, with no major differences between the Spanish and British groups in views on this topic (see Table 3.9). Within those who answered positively, 92% were clear that the use had to be both supervised and alone, in contrast with a small proportion (6%) who thought only supervised use was appropriate.

Table 3.9 Views on children with ASD computer use.

	Total	%
Should	88	92.6
Should not	5	5.4

	Should (88)	%
supervised	5	5.7
alone	0	0
both	81	92

What types of computer use are more beneficial for children with ASD?

As described earlier (see Section 3.1.3), respondents were asked to rate a series of computer uses according to how beneficial they thought they might be for children with autism: word processing, speech recognition, pointing devices, communication software, educational software, computer games, robotic toys, electronic toys, internet browser, graphic design software, programming, and email[1] (UK group only).

Overall, as it can be seen in Table 3.10, the means of respondent opinions with respect to different types of computer use were generally positive, with 3 being the middle point, 1 being very detrimental, and 5 very beneficial. Mean values between 2.5 and 3.5 may be considered more neutral than beneficial or detrimental. There were two main groups of uses which emerged: those clearly considered positive (such as word processor, speech recognition software, pointing devices, communication software, educational software, and even games), and those possibly less so (such as electronic toys, internet, graphics programs, computer programming and emailing).

Table 3.10 Beneficial types of computer use.

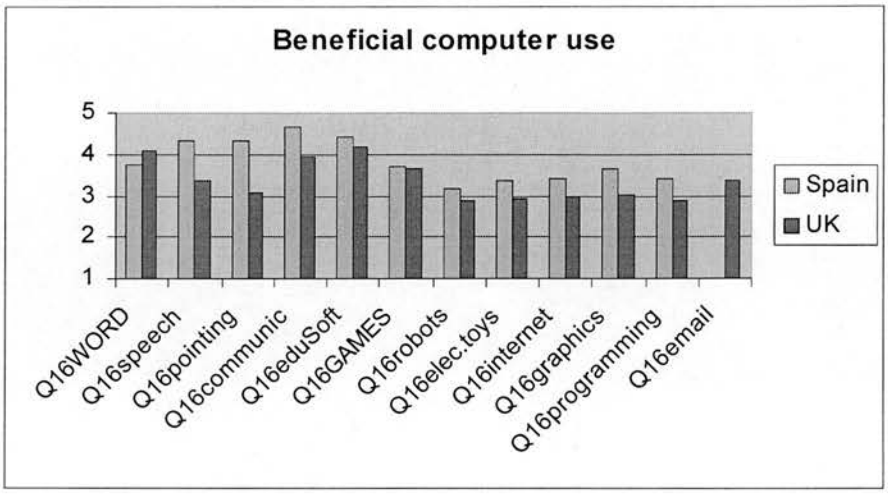
	Word	Speech	Point.	Comm.	EduSof	Games	Robots	El.toys	Net	Graph	Progra	Email
Minimal	3.79	3.88	3.80	4.25	4.35	3.69	2.97	3.11	3.18	3.20	3.19	3.55

These results are perhaps not surprising since the uses considered more beneficial are also the ones that are typically more widely used in the context of children's education and also the most obvious ones for using with children with communication difficulties. The less favoured uses are ones not so readily available in the school setting (e.g. robots or electronic toys) and may also require a little bit more in the way of technical skills to be able to facilitate their use (e.g. graphics or computer programming); their educational potential may also not be immediately apparent to those who have not previously used them with children with ASD or in educational settings (e.g. internet, email).

From Figure 3.7 it would appear that the ratings of the Spanish respondents are more positive in general, than those of the British respondents, and although following a similar pattern with respect to most kinds of uses, diverge more in relation to the use of speech recognition software and pointing devices. Once again however, these results have to be interpreted within the context that the British group had more experience of IT and computer use, both in general and with children with ASD in particular.

[1] Email was the second item of the list, but it has been reported last for clarity of presentation.

Figure 3.7 Beneficial types of computer use.



Computer uses

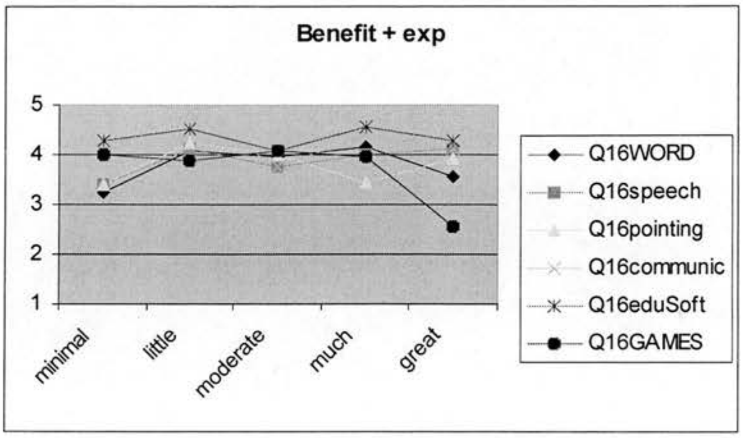
Perceived benefits according to rater's level of ASD experience

When looking at how experience with children with ASD might have influenced respondents' opinions, only those with experience were considered in the analysis below. Table 3.11 shows respondents' ratings of the potential utility of contrasting kinds of IT-supported approaches, stratified by level of prior experience with ASD. It is important to bear in mind the number of respondents in each group: minimal, 9, little, 11, moderate, 7, much, 20, great, 11. Opinions relating to the first six uses of computers (cluster A - see Figure 3.8 over), those considered the most familiar or obvious, were similar across all levels of ASD experience, with the only clear exception being in ratings of the use of games; here the group with the most experience considered this particular use less likely to be beneficial than the rest (see over).

Table 3.11 Benefits according to level of ASD experience.

	Word	Speech	Point.	Comm.	EduSof	Games	Robots	El.toys	Net	Graph	Progra	Email
Minimal	3.25	3.42	3.42	4.13	4.30	4.00	2.92	3.33	2.42	3.00	2.93	2,67
Little	4.06	4.13	4.25	4.83	4.53	3.88	3.00	3.21	4.00	3.63	3.25	5,00
Moderate	3.95	3.75	4.00	3.75	4.10	4.10	3.25	3.10	3.30	3.90	4.10	3,80
Much	4.15	4.00	3.43	4.42	4.56	3.94	2.97	3.19	3.03	2.84	2.90	3,18
Great	3.56	4.10	3.92	4.11	4.28	2.56	2.69	2.69	3.14	2.64	2.78	3,11
Total	3.79	3.88	3.80	4.25	4.35	3.69	2.97	3.11	3.18	3.20	3.19	3,35

Figure 3.8 Benefits according to level of ASD experience (cluster A)

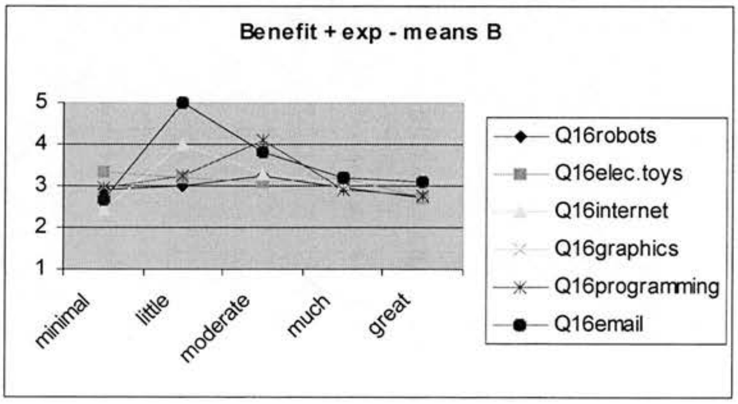


Experience with ASD

The second clustering of computer uses elicited a more varied set of responses (see Figure 3.9). In general terms, respondents with little to moderate experience had the more positive opinions, in particular about the use of email, the internet and graphic software (it needs to be remembered that email was only included in the UK questionnaire).

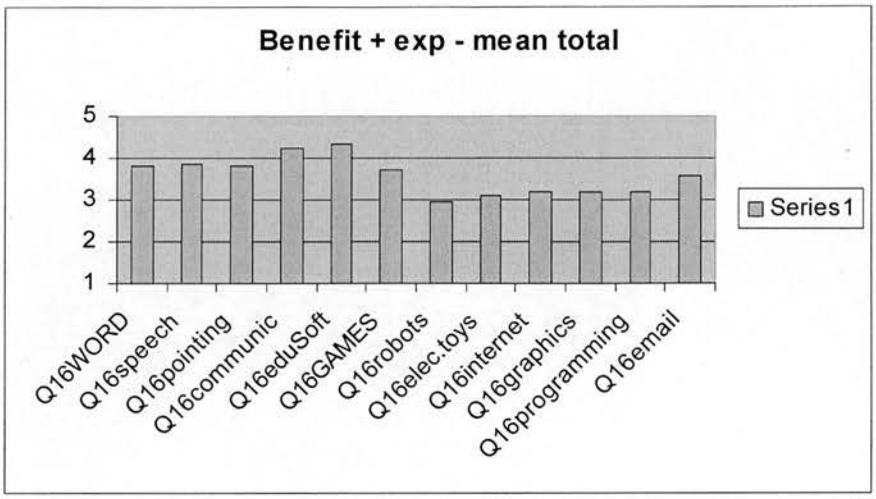
Most opinions were closer to the mid-point of the rating scale for cluster B tools than for the first cluster of uses, i.e. seen as neither beneficial nor detrimental. Respondents with minimal experience of ASD valued the internet and email negatively, whereas the respondents with great experience rated robots, electronic toys, graphics and computer programming as less beneficial.

Figure 3.9 Benefits according to level of ASD experience (cluster B).



Experience with ASD

Figure 3.10 Benefits according to level of ASD experience (Total).



Experience with ASD

Perceived benefits according to raters' level of computer use

Table 3.12 shows mean ratings of each of the 13 kinds of IT support stratified by raters' level of computer use. It seems that opinions were more positive when respondents had more personal experiences of computers, except for the use of games with children with ASD, which they rated least positively. This might be explained on the basis that more experienced users may be able to see the potential benefits of some uses better than those who are less familiar with computers.

Table 3.12 Benefits according to level of computer use.

	Word	Speech	Point.	Comm.	EduSof	Games	Robots	El.toys	Net	Graph.	Progra.	Email
Low	3.41	3.17	3.21	3.58	3.83	3.63	2.30	2.31	2.98	3.23	3.19	2.56
Moderate	3.99	3.86	3.77	4.41	4.32	3.72	3.06	3.28	3.27	3.35	3.15	3.53
Intense	4.20	4.23	3.99	4.55	4.63	3.42	3.19	3.27	3.53	3.77	3.44	3.60
Total	3.92	3.79	3.71	4.29	4.26	3.68	2.94	3.03	3.23	3.36	3.17	3.35

The least positive opinions were seen in raters with low personal use of computers when rating the potential utility of robots, electronic toys and email. It is difficult to account for this difference, unless we consider these uses as not having any obvious advantage, but opinions about the internet were slightly more positive than those about email, which is a little bit surprising since both are part of the same technological culture.

Figure 3.11 Benefits according to level of computer use (cluster A).

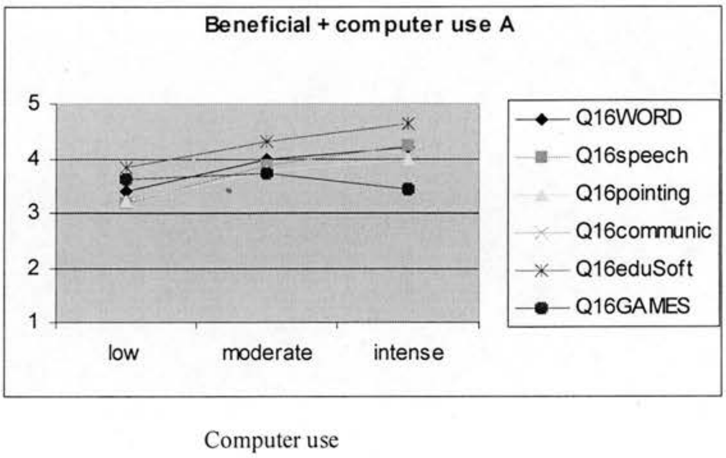
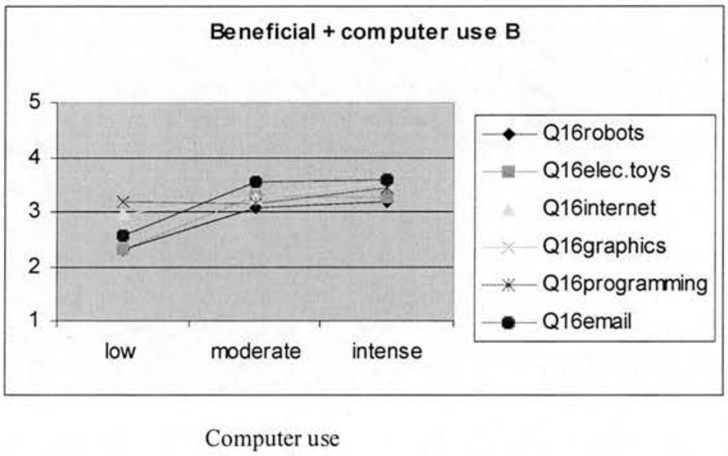


Figure 3.12 Benefits according to level of computer use (cluster B).



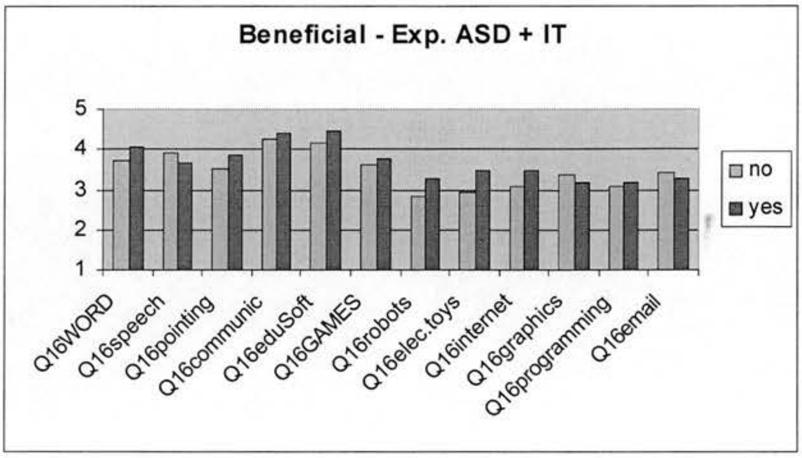
Perceived benefits according to raters' experience of using computers with children with ASD

In general terms, respondents with experience in using computers with children with ASD had more positive opinions on a wider range of IT uses than those without it, especially about the use of robots, electronic toys and the internet (see Table 3.13). However, the profile of ratings, shown in Figure 3.13 (over), is very similar for both groups.

Table 3.13 Benefits according to experience of using computers with ASD.

	Word	Speech	Point.	Comm.	EduSof	Games	Robots	El.toys	Net	Graph.	Progra.	Email
No	3.73	3.89	3.53	4.25	4.16	3.61	2.84	2.93	3.05	3.37	3.07	3.41
Yes	4.04	3.65	3.88	4.42	4.48	3.75	3.27	3.46	3.46	3.19	3.19	3.29
Total	3.92	3.84	3.71	4.29	4.31	3.69	3.03	3.15	3.22	3.34	3.15	3.35

Figure 3.13 Benefits according to experience of using computers with ASD.



Computer use

3.1.6 Discussion

From the questionnaire data reported in this chapter, teachers and education professionals would appear to have a positive attitude towards the use of computers with people with ASD and they seem to agree that while supervision is needed, work alone is also possible. The majority of respondents also used computers themselves and liked them, finding them very useful on a variety of fronts, as previous work has shown. As expected, the greater the use of computers, the more positive the responses, as in the relation between experience with computers and assessment of their potential utility for people with ASD.

Responses in the Spanish group were marginally more positive than in the British group in terms of finding computers more useful and beneficial, although much the same kinds of uses were identified as most and least beneficial as in the British group. Given that the Spanish group used computers less intensively and had less experience in working with children with ASD and computers, this more positive evaluation might be due to higher expectations not having yet being frustrated by experience, or could simply be due to this group being consistently more positive in their responses. The difference in levels of experience with people with ASD was probably due to the differential sampling of the two groups of respondents and should not therefore be considered representative of both countries. In the Canary Islands, the diagnostic process for autism is still in its early stages, and screening for high functioning autism and Asperger's syndrome is not yet widely in place.

Although respondents were aware of the benefits of word processing, speech recognition, pointing devices, communication software, and educational software, they seemed to hold a mixed opinion of the potential utility of robotic toys, electronic toys, internet browsing, graphic design, programming and email. This might be due to lack of knowledge of the devices/applications themselves, in a group not required to be familiar with such technology. Another reason could be lack of access to specialist research such as that referred to in the literature review in Chapter 2, showing the great potential of such applications/devices (see section 2.4.2, p.49).

Given the importance of early intervention for children with ASD, the teachers' role in this, and their additional role as a source of expertise for parents of such children, this study has highlighted the need to better inform teachers of the potential of a wide range of computer resources for children with ASD and to dispel any notions that working with computers may simply exacerbate the problems children with ASD already face in their daily interactions.

3.2 Interview study 1: How IT is being used with ASD people by different professionals

The purpose of this small study was to obtain a more detailed and descriptive view of what different professionals working directly with people with autism were doing with computers. Subjects were selected to illustrate a variety of educational and therapeutic contexts but not necessarily to be representative of more general practices.

3.2.1 Methodology

Five professionals from the educational field were approached, having been identified through personal contacts, referrals and participation in an autism specific internet forum. Participants were: a teacher working with high functioning children with ASD in a special unit within a secondary school; a communication unit coordinator working with the same type of children, again within a mainstream setting; a Spanish specialist in education (pedagogy) working with primary school-age children with ASD outside school; a teacher working with young children with ASD within a special school; and a teacher trainer in charge of the computer department at a day service centre for adults with ASD. It was believed they all had unique contributions to make this kind of research enquiry.

An interview guideline (see Appendix C) was designed to ensure that all the necessary information was gathered on the respondents' use of computers with people with ASD. The interviews were flexible in their development, with new questions being prompted by the answers; in some instances, this meant that some planned questions had to be dropped if time was lacking (e.g.: views on training needs). Four interviews took place face to face, and although recorded, for three of these, the material presented here is based on written notes alone due to recording malfunction. The fifth interview was carried out by email, and as such lost the flexibility of the face to face approach; it nevertheless allowed answers to all of the questions to be given and gave the respondent time to think about her responses.

3.2.2 Case 1: A Teacher in a Special Unit within a Secondary School

The first respondent was a Maths, Computing and Modern Studies teacher in special unit within a secondary school and had been in the post for three years. Nine children attended the Unit, which was staffed by four teachers, one auxiliary teacher and a speech and language therapist. There were eight PCs in the Unit, but not all of them were accessible to the pupils, who had a ratio of one computer to two pupils. Access was restricted and monitored all the time by a member of staff to ensure they were not using the internet, or modifying the settings.

This teacher had used a program called 'Success maker' for independent learning of English and Maths over the past two years, three times a week, in sessions of 40 minutes. He thought that the program was easy to follow, with questions explained and presented in an exciting way, and that it was a good tool for assessing how students were getting on. On the other hand, it only worked for those pupils who already had independent skills, causing difficulties for others and resulting in their scores not being an accurate reflection of their real ability. According to the teacher, these students may have had attention problems, difficulty in working for a particular period of time, or may not have liked either being in control or being told by the program that they had made a mistake.

The internet was used in Maths and Modern Studies to encourage students to create images for diagrams and to gather information, e.g. setting up tasks requiring the use of internet searching engines. The teacher had observed that it was difficult for some of the children with ASD to cope with tasks that were too open-ended; some would become frustrated if they could not find what they wanted quickly enough or were confused by search results. As a response to these problems, the teacher started to design more specific tasks: e.g. when the task concerned planning a trip to the cinema, children were asked to check directions and listings first, or when information of recent news was needed, children were provided with the web pages of some newspapers. He would also support them with emailing and phone skills. The teacher in addition reported on children talking about chat rooms (virtual public spaces where people log on and join in conversation), of which some were aware of the dangers, but other children clearly did not understand that some people could affect a different personality in a virtual environment and might not be what they seem.

This teacher noticed that children in general prefer a variety of stimuli for learning, to which computers were a welcome addition. In the specific case of children with ASD, however, if information is presented nicely and personalised, it may become a distraction: they may ignore the content and become fascinated with the medium itself, a difficulty less likely to emerge in response to a more traditional medium (e.g.: a book) that requires more 'focusing' skills. On the other hand, while some children with ASD may struggle to understand what the function of an index is within a book, they may be able to access information while at the computer (with instructions), and start grasping that concept over time.

Regarding future use of technology, it was suggested that an interactive whiteboard could replace a blackboard, but that while the moving images might make subjects more interesting, there would be a greater risk of it becoming distracting. The teacher interviewed was not aware of any particular way to use computers to learn social skills other than using social skills programs or using the internet to find out information relating to social situations.

3.2.3 Case 2: A Co-ordinator of a Special Unit within a Secondary School

The second respondent was the coordinator of Special Unit in a Secondary School who had also worked with people with ASD before taking up her current position. Fourteen children attended the Unit, which provided supervised access to five networked PCs, two stand-alone PCs, and three Macintoshs, and unsupervised access to three pc laptops, an almost 1:1 computer: pupil ratio.

Although the Unit did not teach a computing class per se, children were reported as being comfortable with computers as tools. The students had access to four mobile computers[2] that could be taken to the classroom, and used at lunch time and during breaks. They used these for writing tasks, spreadsheets, emailing and games, as well as independent living skills (e.g.: Streetwise, Travellers Cheque), language, and maths skills. A dyslexic autistic student also used 'Co-writer', a program that predicts what the user may be writing, especially to enable him to type in exams.

A concern about stress management inspired an art therapy scheme being introduced into the Unit, as this was thought to be a means of expression and stress release which could have a positive impact on children's self esteem. In this context, the coordinator could see the potential of computers to help build a visual resource library for the scheme. In addition, she strongly recommended 'Oregon trial', a social game which she had experience of using with adults.

Access to computers was also used as a reward, except when a child was upset (and badly behaved): the calming effect may not justify taking the risk of the child perceiving the computer as a reward for his behaviour. Typing was used with a particular child who did not communicate for long periods of time. This child could speak and was able to contribute to a conversation but could not cope with

[2] Desktop computers set up on a mobile desk.

being the focus of a conversation. During the periods when he would not speak, teachers would use typing and miming, and kept on teaching him about the communication process. It was hoped that the child would learn that communication was rewarding, because it allowed him to control things. The experience of this respondent was that children with ASD "shut down under pressure", and thus, that relaxed, happy environments produced relaxed, happy children.

3.2.4 Case 3: A Pedagogist

The third respondent was a Spanish pedagogist with seven years of experience with children with ASD, having used computers with three young children with ASD in his private practice for five months. He used a PC with six educational games for different ages and a phonological test application. Children had 45-50 minute sessions twice a week, and the computer was used frequently, but not all of the time: with one particular child, the computer was used 80% of the time, but in general, only a third of children's sessions were spent at the computer.

For this interviewee, the computer was a just a means of achieving an objective within the programme for that child, thus the specific goals of using computers depend on the child's needs. For example, in order to improve reading fluency he would use a story at the computer, a karaoke type of activity, or repeating a text aloud. If the goal were to develop pre-reading skills then the computer software would be used to break a word down into syllabi to demonstrate how to compose words.

He started using computers after learning from other professionals that it worked:

> "*It's a tool highly contingent: the consequence of an action is immediate and constant (e.g.: Press key 'N', and an 'n' appears). It always follows the same action and not an other. Most of them, when they understand the functioning of a computer, become fascinated. e.g.: some children do not speak, but they know how to switch the computer on and play, and maybe they cannot get dressed by themselves... the motivation is strong.*"

His observations were that children with ASD are interested in computers and the format of a game seems to appeal to them, sustaining attention for a longer time, with some exceptions, depending on the level of attention of the child beforehand. In some instances, children may become very absorbed by the screen and ignore the therapist, showing a joint attention deficit. He points out that *"it is intended that the computer won't make social development more difficult"*. The solution suggested was to limit the time using computers, television and video, otherwise it can be difficult to bring the children to pay attention to others. It was recognised, however, that it is possible to do something at the computer to address joint attention difficulties, through demanding that the child pay attention to the therapist.

For the pedagogist, leaving the child to play alone on the computer is a way to manage their free time, is an extra activity that he is likely to enjoy, and can reduce stereotypical behaviour while playing:

"The computer provides a stimulus which is a little better that the self stimulation".

Although such activity should not be over encouraged, from an educational point of view, the child could be guided to learn that what he does has an effect on his environment, making it another opportunity for learning. Overall, the pedagogist's opinion about computer use and children with autism was that while computers may be beneficial as a part of a general program, so would any other tool.

3.2.5 Case 4: A Teacher at a Special School

The fourth respondent was a teacher who had been working at a Special School for three years. Children at the school had severe and complex learning difficulties, were 5-17 years old and twenty out of the seventy pupils had ASD. The teacher interviewed had six 5-7 years old children in her class, two of whom had ASD, and was supported by a nursery nurse and two auxiliaries. The school had a ratio of one computer to four children, with at least one computer in each classroom.

The pupils had access to computers two or three times a week, in sessions of thirty minutes. Although some children were able to access computers independently, in the majority of cases they required the teacher's assistance. The teacher usually guided the children through activities in a sequence, using 'Boardmaker' symbols, and supported them to write a story with 'Clicker 4', a program that allows the insertion of images, sounds, and text and can print out the stories the children have compiled. The school also used 'Kid Pix', a drawing tool with sound effects, to make animated pictures. She realised that lack of confidence with the software was what stopped many teachers using computers with children.

She believed children with ASD enjoy the repetition provided by the computer, and that some of those who are at a very early stage of development seem to benefit from the cause and effect process they experience using the mouse. Some literacy skills games were too advanced for her pupils. She gave different programs on different days to those who find it difficult to make choices. According to her experience, most activities develop naturally:

"It's hard to find something they are interested in, so if it is computers you stick with it".

3.2.6 Case 5: A Computer Department Co-ordinator at an Adult Centre

The fifth respondent was a teacher-trainer who had been coordinating the Computer Department of a day service for adults with ASD for the past five years. An average of fourteen adults, aged 19-40, with diagnosis across the spectrum, made use of the service at any given time. The centre had 4 computers with a ratio of two computers to each service user attending their IT sessions. These sessions lasted two and a half hours in the morning and one and a half hours in the afternoon. One instructor worked with two users at a time, assisting up to twenty service users per week. They had access to a drawing tablet, digital cameras, scanners, networked computers, broadband, a music keyboard, and web cameras, among other devices.

Service users varied from those with severe learning difficulties to those able to self-teach HTML (a web design language) and foreign languages. They carried out several activities with the support of staff: some worked towards entry level vocational qualifications, others used a paint programme, created calendars, or set up a personal web site, and the majority used email to keep in touch with their families and send them photos. Users with severe learning difficulties might take up to a year to develop some basic IT skills, whereas individuals with Asperger's Syndrome might learn a lot faster. The service provided different applications ranging from word processors, maths and language programs to games. Users also had access to a social skills CD-Rom developed for users with ASD, 'ASILesp My Friend Ben', but the interviewee was not aware of it being in much use.

The teacher-trainer considered that the computer activity of adults with ASD provided motivation, could reduce anxieties and it was good for self esteem as it built confidence in the users' own ability.

3.2.7 Conclusion

This section has highlighted a range of activities and potential uses of computers for people with ASD and how in practice these are being put to use in a variety of settings. It appears that the potential for social skills development within educational settings remains relatively untapped. Although one teacher was aware of the possibilities of a specific social game, there was not room in the curriculum to include it within a school setting. Having access to a social skills application of course does not guarantee that the users are going to use it, or if they did, that their learning would be transferable without being integrated into a wider program of social skills development.

3.3 Interview study 2: Effective communication techniques as identified by volunteers working in an ASD Social Interaction Project

As described in Chapter 1, children with ASD have difficulties understanding social situations and displaying appropriate behaviours in such contexts. Many educational programmes have successfully taught social rules in isolation but in general the children fail to transfer these later to their daily life. This has led practitioners to attempt more naturalistic approaches. Given that this thesis studies the potential of a computer-based intervention, it is necessary to know what makes a face-to-face intervention effective in fostering social interaction in order to inform the design of a computer-based approach with the same social goal. This section reports on eight volunteers' views of the relative success of the various techniques and approaches used in a social interaction project which was set up to develop social understanding in a naturalistic environment (for full details of this project, see Dunlop, Knott and MacKay, 2002).

3.3.1 Background

This section is focused on learning from practitioners' experiences in communication and interaction with children with ASD through their accounts of their practice. For example, Edelson (2000) explained that when observing the behaviour of children with autism, looking at their actual social-emotional age would be more effective than trying to match their behaviour with their chronological age peer group: if the social-emotional age is around 2, then the child may refuse to follow some requests or be stubborn and self-centred, whereas a social-emotional age of 8 would be characterised by trying to model adults and older peers, as well as following rules to the letter (Edelson, 2000). This developmental rather than chronological age approach would allow family, therapists and teachers to hold more realistic expectations of the behaviour of the child, as well helping in tailoring the specific aims of their educational interventions more appropriately and precisely.

From a similar perspective, Janert (2000) suggested that it is possible that the child with autism is communicating, but that his signals are so subtle that nobody notices them or interprets them as communicative attempts. This could be the case of a four-year-old who, instead of talking to his mother, was trying to communicate as a baby would while she is expecting a bold spoken message from a nursery-age child. Children with ASD may be also more responsive to interactions or games appropriate for younger children (Janert, 2000).

Another important issue considered by some authors is motivation (Lehman, 1998a; Murray, 1997; Potter and Whittaker, 2001): motivation to do different tasks, but more importantly, motivation to communicate. It is not only knowing how to communicate, but seeing a reason to do it (the why) which will get a child with autism to communicate (Boswell, 1999).

Boswell (1999) made a number of different suggestions to facilitate successful communication:

1. using a combination of gesture, pictures, words and objects.
2. using visual supports is important because they are stable, attract and hold attention, reduce anxiety and make concepts more concrete.
3. using short and simple sentences; using the same words in the same situation.
4. speaking slowly and clearly and waiting for a response.
5. exaggerating the tone of voice and facial expression.

Potter and Whittaker (2001) also advocated a minimal speech approach, in order to keep the verbal load low to prevent confusion. They used the term 'proximal communication', based on the social strengths of children with autism, who seem to be good at approaching adults who are passive and quiet, at maintaining proximity to adults when there are no props around, and at responding to rough and tumble play. The authors therefore encouraged playful, non-verbal interactions to develop social skills (see Table 3.14).

Table 3.14 Specific communication abilities (Potter & Whittaker, 2001).

Intentionality	Communicative use of vocalisation
Social timing	Communicative use of gesture
Spontaneous communication	Responsiveness to a widening range of social games
Turn taking	Beginnings of joint attention
Social anticipation	
Communicative use of eye gaze	

In a similar line, the National Autistic Society recommends the use of structure to help the child make sense of an otherwise confusing world. They believe in starting from where the child is and in capitalising on his strengths and that holding positive attitudes and appropriate expectations will have a positive impact on the child's self esteem and confidence. The creation of a harmonious atmosphere, calm and focused, without clutter, allowing the child to feel comfortable and relaxed, is also promoted. They encourage staff not to be confrontational and to use supported rehearsal to practice appropriate behaviour in challenging situations (National Autistic Society, 2001c).

3.3.2 The project

The social interaction project was presented to the children as a 'friendship club' and it was staffed by two teams of 4-5 volunteers from a variety of backgrounds: teachers, nurses, educational psychologists, clinical psychologists, social workers and researchers. Each team of volunteers worked with three different groups of children. One team worked first with children of primary school age (5-11 years old), then with children at secondary school (12-16 years old), and finally, with children at primary level again. The other team started and finished with a secondary school group of children, having the primary group in the middle. Each friendship club took place once a week for 12-16 weeks.

Each group consisted of 6-8 children, the majority of whom had a diagnosis of ASD. During the friendship club sessions these children were involved in different real life activities, such as games, snacks and outings. Other activities included story telling, role-play, use of computers/technology and creative projects. Activities took place in big group and small group settings, and sometimes one to one. The teams worked on broad categories of social and emotional understanding, conversation skills and friendship skills.

3.3.3 Methodology

This interview study took place over a year, starting after the first 'friendship clubs' had finished until the third had finished. Eight participants were selected from the two teams, including each team leader, and representative of a variety of backgrounds: three teachers, one researcher, one nurse, one clinical psychologist and the two team leaders with a background in education and psychology, respectively. Although it was intended to have an equal number of volunteers from both teams, not all staff members were available, and so there were five from one team and three from the other. Interviews were tape recorded and transcribed later. The focus was on gathering their experiences with communication and social interaction techniques, and a semi-structured interview was designed around the four broad questions shown in Table 3.15.

Table 3.15.- Interview questions
1. How would you measure communication skills? (i.e.: eye-contact, spontaneous conversation, negotiation) 2. What do you think was more effective: small group or big group activities? (specify) 3. Which techniques worked for you? (the ones you used, think of individual cases) 4. Which were detrimental?

3.3.4 Findings

After transcribing the interviews, keywords and relevant comments were looked for. The next step was trying to find main themes, but given the small number of people interviewed, the most useful findings came from summing up their diverse contributions, which in fact complemented each other more than they overlapped.

Measuring communication skills

"It is very difficult to measure communication skills"

The variety of responses showed the range of communication possibilities and the difficulty in making decisions about what to measure and how to do it (see Table 3.16). Some interviewees would list different elements to look for when trying to measure communication skills, such as splinter skills (see below), aloofness, language, etc. whereas others were more concerned about theoretical issues such as definition of communication, theoretical perspectives and decisions about what was needed. One respondent pointed out that communication requires motivation as well as skill.

Table 3.16 What to look for.

Splinter skills (eye-contact, gesture, closeness, frequency of interaction) Aloofness Empathise, sympathise Read others' feelings Sort of language (flexible, functional, perspective of the other, purposes and intentions)	Social use of language, interaction & communication Understanding Self-expression Awareness of mental state (self, others) Motivational factor Personality factor Isolation Negotiation

The above elements could be grouped into four main categories: directly measurable skills, sense of self, sense of others and communication skills. Measurable skills, called "splinter skills" by one of the interviewees, relate to features such as eye contact or frequency of interaction. Sense of self refers to the individual's ability to recognise himself, his thoughts and emotions, and his individuality. Sense of others includes manifestations of awareness of the other, such as acknowledging somebody's feelings, interests, and the like, and includes ability to sympathise. Communication skills are the appropriate use and understanding of language, and negotiation skills (see table 3.17).

Table 3.17 Categories.

Measurable skills	Sense of self	Sense of others	Communication skills
Eye-contact	Aloofness	Feelings	Use of language (flexibility)
Gesture	Isolation	Thoughts	Understanding
Closeness	Self-expression	Interests	Negotiation
Frequency of interaction	Recognising own emotions, mental state	Mental state	
		Empathy	
		Sympathy	

Strategies

"Different people need different things".

All interviewees mentioned at some point that it was important to look at each individual, because what is good for one may not be for another. When commenting on strategies that worked in general, staff members of one group were more concerned on how they approached each individual and their body language, whereas the members of the other team mentioned activities such as role-play or games, and environmental elements, such as structure and distractions. They all seemed to agree on the positive effects of working within small groups as opposed to the difficulties experienced by some within the larger group, due to anxiety and distractions. Most volunteers found that small group activities best facilitated interaction between the children themselves (see Tables 3.18 and 3.19).

Table 3.18 Strategies that worked.

	Teenage group	**Younger children group**
Strategies that worked	Not being confrontational: not forcing eye-contact, side by side, not talk with hands,(gesticulating) not gesturing too much, not use much facial expression Suggestions not direct Reassure Physical approach: beside, respect space addressing children by name, being very clear, reducing verbal demand, using quiet, calm voice <u>Small group:</u> exploration <u>Big group</u>: to practice new skills	Language development package Role play Instant feedback Games: learning, motivation, natural more likely to generalise Having a theme that includes children's interests <u>Small group</u>: comfortable, less distractions, practice in isolation

Table 3.19 Strategies that did not work.

	Teenage group	**Younger children group**
Strategies that did not work	Unreasonable demands No gains if stress <u>Big group:</u> too stressful some couldn't do it	Worksheets (dropped them) Lack of structure Difficulties with: guessing peoples' feelings, putting on facial expressions, assessing others <u>Big group</u>: distractive, some couldn't do it at all

These strategies could be classified in three main groups: body language, structure and atmosphere. Within the body language group there were strategies such as positioning, confrontation, voice, gesture, verbal demand, and eye contact. Structure-based strategies included distractions, time management and small/large group approaches. Finally, volunteers highlighted the need to work on creating an atmosphere which was calm, reassuring, quiet, and clear. It is important to highlight that the staff also felt that they had improved in their interactions over their time within the project:

"we got better at getting things out of them".

The differing personal and professional profiles of the volunteers was also reported as making a difference to the group dynamic in team activities (by varying degrees of structure). Also relevant was the learning process from working with one age group of children and then another, the sharing of information between the two volunteer teams, and the growing rapport among all of the volunteers.

3.3.5 Discussion

The strategies that the interviewees identified in interviews as most successful were broadly consistent with those reported in the general literature on ASD. In fact, it could be argued that the strategies they mentioned were the ones they "knew" were better, rather than the ones they really experienced, as all the interviewees had previous experience or a specific qualification in the field of autism. The fact that they were more aware of particular strategies may cause them to use them more.

On the other hand, there were occasionally differences in interpretation of the kinds of advice given in the literature, such as the description one of the teachers gave of avoiding 'confrontational' approaches. She explained not being confrontational as not talking with the hands, not gesturing too much, and not using much facial expression. This can possibly be explained by her understanding of the difficulties children with ASD may have in reading facial expressions, as evidenced in her comments in the interview. These suggested that she was aware of the children's difficulties in capturing the meaning of such signals, and that by not relying on them to convey a message, there was a better chance they would be received.

Overall, the strategies that worked best were related to modifications to the structure of interactions (no distractions, organisation of activities, small group), to body language (positioning, verbal demands, gesture, facial expression), and to atmosphere (quiet, calm). These are not all the elements considered in the literature but are part of it. Making appropriate demands and attending to the individual's needs, interests and strengths seem to be very important too, and motivational issues should be considered.

With respect to the structure, working with a computer requires the focus to be on the monitor (preventing distractions); everything is normally in the same place and similar actions produce the same effects; there is also typically a constant use of steps to perform a task, which helps in sequencing. Computers usually make extensive use of visual information, and the layout can also be configured to suit a child's sensory needs (softer colours, disabled sound, reduced number of items on desktop, etc.). They also allow the child to work at his own pace and experiment in a safe way, with any mistake easily correctable . Thus, computers provide a structured environment that fits well with the features identified above as being most effective in establishing interaction with those with ASD.

In relation to body language, an interaction mediated by a computer would force the adult or second person to sit behind or besides the child, therefore, impeding a confrontational positioning. This arrangement does not require eye contact or face reading skills, as everything is centred on the computer. Being focused on the computer also provides a common interest that the adult can refer to, keeping the child motivated. Therefore, computers require the facilitator to be into a non threatening position, regardless of his personal skills in this area, making this strategy more effective than in a natural setting, where the position of both parties is chosen freely.

To sum up, there are several strategies in interaction that seem to be appropriate for people with autism, and computers may provide an environment within which these strategies can be implemented without relying heavily on the experience or intuition of the facilitator.

3.4 An attempt at a robot-based interaction prototype

As highlighted in Chapter 2, the applications of computer-based activities to improve or practice social skills are endless. Early choices in this research were dictated by access to the necessary resources as well as a drive to follow up on some previous lines of work. In particular, the promising results of Weir and Emmanuel (1976) inspired the attempt to replicate this study, and a robot turtle prototype was built.

3.4.1 Robot turtle

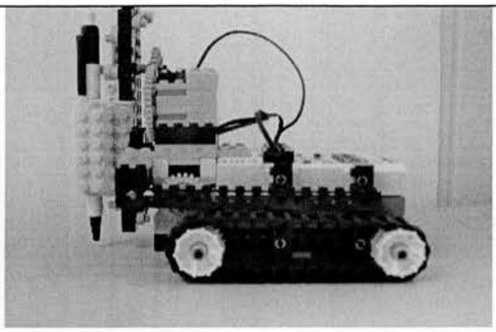
As already described (p.42), an early paper of Weir and Emmanuel (1976) presented a case study of a child with ASD using a Turtle robot. After a few sessions the child started making a connection between his state and the Turtle's state, such as instructing the Turtle to go UP, and standing up from the chair at the same time. The study showed some positive effects but only in a single case. More recently, Dautenhahn (1998) has explored the use of robots in interaction with children with ASD, but she used autonomous robots, programmed to react in a particular way to the children rather than controlled or 'programmed' by the child (see more details in Section 2.4.2). This motivated an interest in replicating the original Weir and Emmanuel Turtle study, but with a group of children with ASD.

A Turtle robot is essentially a semi-spherical structure with wheels and a pen in its centre. It was developed in the 70s to allow children to explore the LOGO language used to program it. LOGO is a very simple language that can be learned by very young children. With LOGO, the Turtle could be programmed to move forwards, backwards and turn at different angles, and by putting the pen down or up, it could draw different shapes on the floor.

Weir and Emmanuel (1976) developed a specific control pad for their experiment, in order to simplify the programming of the turtle, which was part of a computer system in an Artificial Intelligence research lab. The prototype built here, 25 years later, required a common PC, and a robotic system easily available: LEGO Mindstorms 1.5. The LEGO Mindstorms robotic system is a tool that fits the constructionism learning style proposed by Papert (1991). It provides its own programming environment, based on blocks of basic instructions that can be dragged and dropped into a sequence of steps; this features of the system can be used to facilitate sequencing and planning, as well as the exploration of cause and effect, and gives the users a strong sense of control and achievement, all very desirable in general, but even more so for children with ASD. Building a robot and programming it is a very sophisticated project that lends itself to team work, demanding negotiation, decision making and creativity, among other skills. It seems an affordable, motivating and engaging project to bring into a classroom to build social relationships among the participants. The essential technical skills are not huge and would not deter a teacher with a positive attitude towards computers.

For the purposes of replicating Weir and Emmanuel's study, the robot needed to be controlled in a similar way, which required an external programming environment. A Turtle-like prototype was built (see Figure 3.14 - over), programmed in Visual Basic, which could move forwards, backwards and turn as well as responding to up and down instructions to move the pen accordingly. The physical design of this prototype was sufficiently stable to carry on with the development of the application to control it. The next stage would have been to improve the physical design of the turtle, develop the controlling environment of the user and evaluate the system.

Figure 3.14: Turtle Prototype



After wide discussion with experts in the fields of education and technology about the possibilities afforded by a Turtle-like prototype for researching interactional needs in children with autism, it was clear that this approach had significant potential, as the examples given above illustrate. Before embarking on a very sophisticated study, however, experts challenged the need for a technological tool in the first place. Their experience with technology in education was that many times it is used because it is possible to use it rather than because it is the most appropriate tool available for their purposes. This point of view opened up discussion of more basic questions within the context of supporting social interaction in children with autism:

- Should children with ASD be using computers at all?
- Do children with ASD benefit from using computers?
- Can computers be used to support social interaction in children with ASD?
- If computers can support social interaction in children with ASD:
  - what specific aspects of social their interaction can they support?
  - are computers better than other tools in this context?
  - are there some ways of using computers that are better than others?

In summary, there are a great many other, and more basic, avenues for exploring the potential benefits of using computers to support interpersonal interactions in children with ASD at this stage in any research in this field. With this in mind, a replication study of a child controlling a robot no longer seemed the most obvious first option, especially as several key issues kept re-emerging during the development work on the robot prototype. These included the difficulties of carrying out research of this nature if the activity in question is an open ended one, and, indeed the even more basic question of whether a computer-based activity was superior, necessary or advisable, when trying to promote social interaction among children with ASD. These questions needed to be answered before embarking on a robot-based study and are therefore addressed and discussed in the following chapters.

Chapter 4: Social interaction in a paper vs. computer- based activity

This first study aimed to explore whether increased opportunities for interaction might be derived from using computers with children with autism. While this may initially be seen as a counter interaction suggestion, many studies and anecdotal accounts would seem to suggest that children with autism often enjoy using computers. This study therefore used equivalent computer and paper versions of the game Noughts and Crosses to observe the interactions between a child with autism and an adult which each of these versions supported.

4.1 Background

As indicated in previous chapters, children with autistic spectrum disorders (ASD) seem to transfer social skills training better to daily life if it is embedded in a natural activity (Potter and Whittaker, 2001). They also tend to enjoy using computers, as these are not threatening, are predictable and are reliable, thus providing a safe environment within which social interaction can take place (Murray, 1997).

Current models of communication (Hargie et al., 1994) require certain elements to be present in any analysis of the communicative process: sender and receiver (communicators), channel, medium, message, feedback, context and noise. Problems with any of these elements may cause difficulties for the whole process. If the information is delivered in small units, one at a time, by a structured, noise-free, unambiguous medium, with extensive use of visual representations, giving the necessary time for the person with ASD to process the message, then an interaction or communicative process may take place. Computer-based activities can clearly be structured so as to provide just such a medium.

In addition, Wolfberg and Schuler (1999) argue that play provides a supportive environment for all children to learn and practice new skills: they work with a play group model where children interact with adults or more capable peers who try to match or exceed (slightly) the level of the child with autism. In the specific case of children with ASD, it is essential that they learn social interaction in a natural setting such as play (see section 1.2.2, p.19). Considering that failing to engage in play with other children is both difficult and very frustrating for children with ASD, as discussed in section 1.3.1 (p.21), Boucher (1999) suggests that learning how to play has the added benefit of enabling them to interact with other children, including typically developing children. It gives them personal satisfaction, motivation and an opportunity to express themselves.

All of the above reasons make computer-based play an activity that provides a natural setting which maximizes motivation, enjoyment and opportunities for social interaction. Before using such an activity as a social tool for children with ASD, a key question arises: is a computer-based play activity superior to a non-computer-based play activity? In other words, are there any features that justify the use of computer-based play activities to foster social interaction in children with ASD?

To start answering the above questions would require a comparison of a computer-based play activity and a non-computer-based equivalent. One study by Antonietti and Mellone (2003) compared a traditional game with a computer version of the same game in order to observe if the different medium had any impact on the way participants, university undergraduates, played. They tried to find out if the cognitive and psychological associations with videogame playing were due to the interactive and multimedia features of the computer or to the contents of the game. The authors evaluated Pegopolis, a board game for which there is a computer version with a virtual board using the same rules, in order to see if the behaviour, strategies and attitudes of the players were affected by the medium. The board game consists of a wooden board with 37 squares and 36 pieces, arranged in such a way that the central square is empty. The goal is to remove as many pieces as possible by piece jumping, in a vertical or horizontal direction, over a piece in a neighborly square, and it finishes when there are not more possible jumps. The authors highlighted some features that may affect game playing under the two conditions:

- frontal perspective: the computer screen provides a frontal perspective that allows the player to identify all of the pieces easily and to assess the best strategy.
- motor control: the computer reduces the cognitive load for eye-coordination and the motor control demands, allowing more time for thinking processes.
- rules embedded ness: illegal moves are rejected on the computer version.
- irreversibility: moves cannot be reversed in the computer version, requiring more thought.
- novelty: technological tools may be more motivating due to their novelty.

The subjects were forty undergraduates, 20 men and 20 women, with a variety of academic backgrounds, who did not know the game previously. Strategies, number of jumps and unplaced pieces were similar; performance did not seem affected by practice but motivation may have decreased throughout the experiment. The main finding was that there was not a significant difference in outcomes in playing either version, other than the speed and ease of movement of the pieces the computer provided.

Antonietti and Mellone concluded that for the type of computer game examined, the associations between game playing and intellectual variables depended on the situations simulated by the computer and not on the computer itself. The same issues still need to be investigated with games that make heavy use of interactivity and other computer features, however, since this may be at the cost of equivalence.

In addition to the features considered by Antonietti and Mellone (2002), McDonald (2002) highlighted the need to look for individual differences in computer experience, computer anxiety and computer attitudes in the context of a study about assessment rather than games, but comparing computer versus paper versions. These elements were taken into account during the design of the study presented here.

Regarding the study of social interaction, most research has focused on the social learning achieved by using social skills software (see Rajendran and Mitchell, 2000; Herrera et al., 2000). Tjus, Heimann and Nelson (2001), however, directly observed patterns of interaction between children with autism and their teachers while using computers. Twenty children with autism and mixed intellectual disabilities worked with a multimedia literacy program over 3-4 months in 20 to 25 sessions of 20 to 30 minutes. The teachers sat beside the students exploring the lessons, and tried to recast the child's utterances for acquisition of syntactic structures.

Tjus et al. (2001) found an increase in enjoyment and verbal expression in both groups of children, but with this greater in the children with autism, and with the greatest increase in relevant speech among those with the least language skills and the greater increase in positive emotions among those with higher language levels. The patterns of interaction were similar in the teachers of both groups, even though the children with autism were a little more off task by the end of the intervention. However, there seemed to be more recasts and praise towards the children with higher language levels, with the children with least language receiving more directives.

4.2 Research questions

The studies described above looked at computer vs. non-computer versions of a game, and at patterns of interactions among teachers and students with autism while working with computers but neither directly addressed the focus of this thesis: the use of computer-based play to foster social interaction in children with autism. The first study used adult participants instead of children, and focused on play strategies rather than social interaction, whereas the second looked at some aspects of computer-mediated social interaction in children with autism but did not investigate play specifically.

The present study was carried out to observe the characteristics of the interaction between a child with autism and an adult when collaborating in a computer-mediated activity and an equivalent paper activity. In particular, it was intended to find out whether the computer fostered greater social engagement, that is, whether the child was involved in more and longer interactions, and initiated more interactions.

Under these conditions two acts of questions arise:

1. Engagement:
   - Does the child engage more in the game when playing at the computer versus the paper version?
   - Does he remain focused on task longer?
2. Interaction:
   - Does the child respond to the adult more when playing at the computer?
   - Does he initiate more interactions with the adult?

In order to answer these questions, the child and researcher carried out an activity, playing Noughts and Crosses, in both a computer and non-computer version. Issues regarding the choice of this game and its design are discussed later in this chapter.

4.3 Methodology

4.3.1 Overview

Ten children of primary school age with a confirmed diagnosis of ASD, but with no other learning difficulties, participated in the study, which was carried out at the children's school. There was an initial cognitive assessment session, followed by two one-off play sessions of 10-15 minutes that were video recorded for subsequent analysis. The activity was playing 'Noughts and Crosses' with the researcher in both a computer-based and non-computer version. A task analysis was performed to ensure that the computer implementation presented the same and equivalent features as the non-computer version. The sessions were led by a predefined protocol including a script of the researcher's behavior and playing strategies. Children were divided into 2 groups matching cognitive and social skill levels, with a first group starting with the computer version and the other with the paper version.

4.3.2 Considerations

Several issues needed to be addressed before deciding on the final design of the study. Decisions about the control group and the intervention protocol design will be explained below, together with a brief description of the task analysis and of a pilot study carried out before embarking on the actual study.

Control group

The aim of the study was to observe if a computer-based activity had a more positive effect on interaction in children with ASD than a non-computer-based activity. In order to control for the possibility that the results might be affected by the learning process of the game itself and/or by growing familiarity with the researcher, it was decided to divide the children in two matching groups on the basis of their cognitive and social skills levels, one group to start with the computer-based activity, followed by the non-computer version, and vice versa. The assessment procedure was also carried out by the same researcher, ensuring that all children had a similar opportunity to become familiar with her before the actual study.

Researcher Protocol

The researcher protocol was designed to create a controlled situation that would nevertheless allow observation of a natural process, a social activity. A compromise had to be reached to ensure that each participant had the same opportunities to interact, enjoy, and to receive feedback, allowing the activity to flow as naturally as possible.

Testing sessions were arranged with the teachers to fit with the school activities of the child. It was requested that each took place in the same room and at the same time and day of the week for each child (including the assessment session). Teachers were requested to prepare the children for the experiment by familiarizing them with the rules of Noughts and Crosses.

The activities took place with both the child and researcher sitting side by side in front of a desk, on top of which there was either a laptop with the game ready to be played, or a paper-based board. Both versions of the game had equivalent features and required the same number of actions (see section 4.3.3, below: computer vs. paper equivalence). The researcher followed a behavioral script with all participants in both versions of the game in order to ensure that all of them interacted with the researcher under the same conditions.

Researcher behaviour protocol

It was necessary to design a behaviour protocol for the researcher that was appropriate and workable, appropriate in the sense of eliciting responses from the participants similar to those generated in a real life play activity with any partner. Since the game chosen was a popular one played by children in or out of school with their peers, family or friends, usually when sitting around a desk or table, the activity itself was also appropriate. The researcher's behavior protocol, however, had two aspects that required separate but simultaneous guidelines: for playing strategies and for interaction patterns.

- **Playing strategy:** The intention was to maximize the motivation of the child by letting him win as many of the games within the match and without him noticing it. This was achieved by a combination of different game strategies (attempting to win, to tie and to lose) used in sequence by the researcher, together with random factors such as researcher's mistakes or good winning strategies used by the participant. This made the outcome of each game less rigidly predetermined and kept the game interesting. The pilot study (see Section 4.3.4) showed that this strategy was not noticed by even the most able children. A detailed script to guide the playing strategy for each of the games was initially defined but was later simplified due to difficulties in carrying it out in real time and in a natural manner.

- **Interaction patterns:** Providing praise, encouragement and feedback was also important in keeping participants motivated but its main purpose was ensuring a consistency in the behavior of the researcher when facing different situations with the different subjects. Again, a detailed script was substituted by more general rules to make it workable (see Section 4.3.6 below, and Appendix G).

Protocol fidelity

It has been noted that the researcher's behavior towards the child had to be the same throughout the study and needed to be simple enough to be carried out consistently and naturally. This required practice, but not having the subjects with the demands of a child with ASD to practice for at least as many sessions as the study required, it was inevitable that a learning process on the part of the researcher took place. This effect was minimized by running the first session for all children first and then the second, in the same child order. As a consequence, at least the second session happened after some practice for all participants. However, the practice effect could not be avoided completely.

4.3.3 Game design issues

Game choice

Noughts and Crosses was selected for of a number reasons: it is widely known board game played by children of all backgrounds, both at home and at school; it involves two players, providing an opportunity for interaction; it has a small set of rules; requires very basic strategies to play it; and it requires simple motor skills. The non-computer version was implemented on paper, with a pen used to mark the Noughts and the Crosses. There are a variety of board versions, but the traditional pen and paper version is the most readily available for children, and it is easily adapted to an equivalent computer version.

Computer vs. paper equivalence

There were four main areas of concern when looking at the equivalence of the computer and paper versions: visual design, physical features, functionality and plane of display.

Visual design

Both paper and computer versions were designed with as similar a layout as possible. The paper version consisted of a number of A4 sheets, presented sideways, with blank grids to the left hand side and results noted down on the right hand side (see Fig. 4.1, over). The computer version presented a board of a similar size to the paper version, using the same font type and size. Colour and sound were not present in the computer version, to avoid distractions, but it displayed a text stating who the winner was (see Fig. 4.2).

Figure 4.1: Paper version.

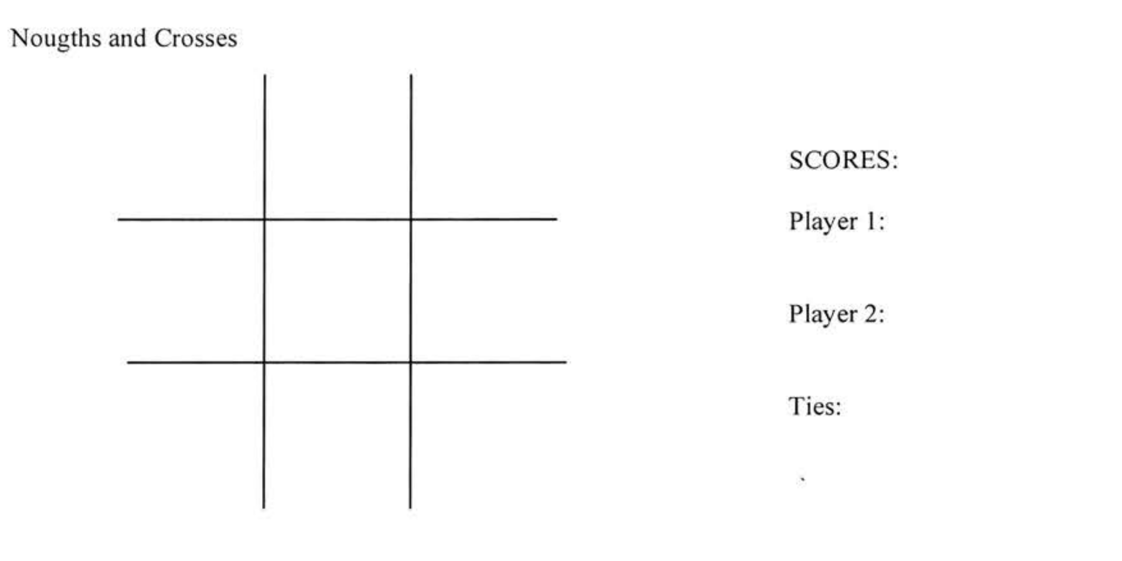
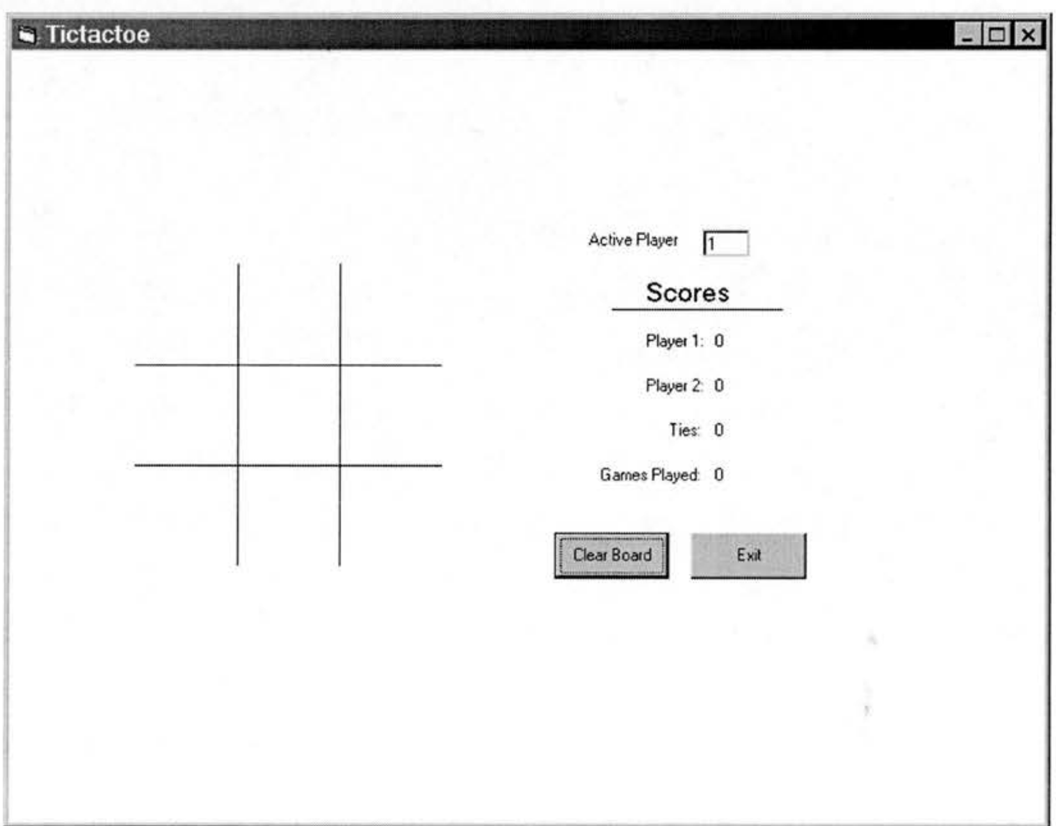


Figure 4.2: Computer version.



Features

As the aim was to minimize the differences between the two versions, no advantage was taken of the multi-media features of the computer, but rather equivalent ways to offer the same features were sought: e.g. the computer turn indicator was replaced by a verbal cue from the researcher (see Table 4.1).

Table 4.1: Features comparison.

Computer	Non-computer
White background, with board pre-drawn	White paper booklet with board pre-drawn
Board to click on, produces an X or an O	Board to write on, an X or an O
Automatic scores	Hand-written scores
Clear Board button	Get a new sheet with clear board (blank grid)
Exit button	Store sheets (close booklet)
Final result display	Verbal result given by researcher
Turn indicator	Verbal indication of turn given by researcher

Functionality

Having equivalent features would not in itself ensure that both versions made similar demands on the children, and further analysis was required. Task Analysis (TA), in the field of Human-Computer Interaction, refers to a set of techniques that try to describe how people do different tasks, in order to predict difficulties and to evaluate a computer system's usability (how easily it can be used). Other uses of TA techniques are the prediction of user performance, finding out how complex the system is and how easily it can be learned (Preece et al., 1994). A particular type of task analysis called GOMS (Goals, Operations -actions-, Methods and Selection rules) focuses on the actions of users by describing the methods required to achieve a goal and uses selection rules to choose between methods. This can be used to check that two methods are consistent, which in the context of this research means that they achieve similar goals through similar means.

In this study, GOMS was used to ensure that the tasks and skills required to play at the computer were equivalent to the ones required to play on paper. This comparison may be performed in terms of number of methods, number of tasks in each methods or the type of operations performed (at perceptual, cognitive, or motor level) as described by Preece et al. (1994). The analysis is shown in Table 4.2 (over).

Table 4.2: Task analysis of Noughts and Crosses.	
Computer version	**Non computer version (paper)**
Method: START MATCH *Goal*: start a new match *Step 1*: launch game *Step 2:* choose player 1 and player 2 *Step 3:* PLAY *Method*: START GAME *Goal*: start a new game *Step 1*: pick mouse *Step 2:* point to the Clear Board button *Step 3:* click *Step 4:* release mouse *Method*: PLAY *Goal*: to play a game *Step 1*: player 1 does a MOVE *Step 2:* player 2 does a MOVE *Step 3:* repeat until END OF GAME *Method*: MOVE *Goal*: write a symbol in a cell *Step 1*: choose an empty cell *Step 2:* pick mouse *Step 3:* point the cell *Step 4:* click (a O or X will be displayed) *Step 5:* release mouse *Method*: FINISH *Goal*: finish a match *Step 1*: pick mouse *Step 2:* point the Exit button *Step 3:* click *Step 4:* release mouse	*Method*: START MATCH *Goal*: start a new match *Step 1*: put new booklet on table *Step 2:* choose player 1 and player 2 *Step 3:* PLAY *Method*: START GAME *Goal*: start a new game *Step 1*: pick board booklet up *Step 2:* pick top sheet *Step 3:* turn sheet to back *Step 4:* put board booklet down *Method*: PLAY *Goal*: to play a game *Step 1*: player 1 does a MOVE *Step 2:* player 2 does a MOVE *Step 3:* repeat until END OF GAME *Method*: MOVE *Goal*: write a symbol in a cell *Step 1*: choose an empty cell *Step 2:* pick pen *Step 3:* place pen on the cell *Step 4:* write a O or X *Step 5:* release pen *Method*: FINISH *Goal*: finish a match *Step 1*: pick board booklet up *Step 2:* pick all sheets at the back *Step 3:* turn them to front *Step 4:* put board booklet down
Method: NEW MATCH *Goal*: start a new match after having played *Step 1*: FINISH *Step 2:* START MATCH	*Method*: NEW MATCH *Goal*: start a new match after having played *Step 1*: FINISH *Step 2:* START MATCH

The task analysis showed that both versions had the same goal structure, the same number and length of methods (number of steps) and present equivalent cognitive demands. There was a slight variation in some motor operations, but then balanced out overall. It was therefore concluded that, when following a specific protocol of use, both versions, could provide the same features and have the same functionality as games.

Plane of display

The remaining difference to be considered between the computer and paper version of the game was the plane of the presentation. The computer provides information on a vertical plane of vision and the manipulation of the game takes place in the horizontal plane, whereas in the paper version both vision and manipulation take place in the horizontal plane. Current technology affords the possibility of horizontal computer displays, e.g. flat screens, and there are other non-standard technologies, e.g. touch screens, which could be used to design a version more equivalent in this respect to the paper version. Similarly, it would not be difficult to arrange a vertical paper version. However, it was initially decided to go with the conventional presentation of games in both media (vertical computer display and horizontal paper version) on the grounds of maintaining a natural setting, i.e. the way children would encounter these games when using both media in their daily life. These aspects nevertheless could potentially influence outcomes differentially.

In a study using brain scanning technology, Klein et al (2004) demonstrated patterns of brain activation that differ for vertical and for horizontal orientation. The relevant experimental condition was that the subjects were in a supine position with the images projected in front of their eyes or upright with a fixed head position. Whether this might affect her performance remains for further investigation.

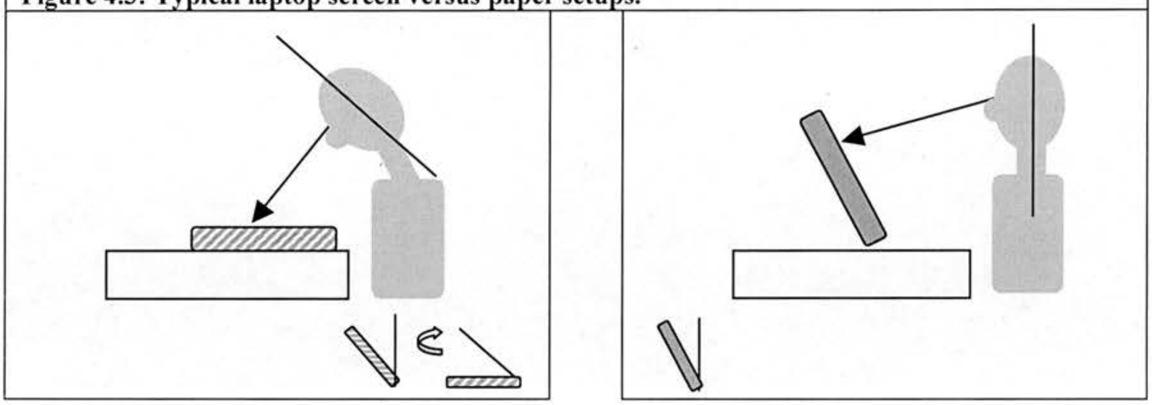
An earlier study by Wainwright and Bryson (1996) found that high-functioning adults with autism performing a detection and identification task responded faster to stimuli presented centrally rather than laterally. If stimuli were presented only laterally, then these adults responded faster to the left visual field. In an earlier study, these same researchers had also found that people with autism had difficulties processing briefly presented cue information as well as problems in disengaging and shifting attention from visual stimuli (Wainwright and Bryson, 1993). What both studies showed was a difference in speed of response depending on the stimuli. The games used in this thesis allow indefinite time to process the information in order to avoid any such difficulties from confoundly results.

When analysing the planes of display it is necessary to look at how spatial information is represented under the two game conditions. Given a bi-dimensional representation of space whether on a computer screen or a piece of paper with X and Y, it is normally established that X would be the horizontal axis and Y the vertical. In the case of a three-dimensional space, with X, Y and Z, it is usual that X is the horizontal axis, Y is perpendicular to X, and Z is perpendicular to both, and vertical, to the floor.

In the context of a computer, two-dimensional information, such as the version of Noughts and Crosses used here, is displayed in a two-dimensional medium, the screen, which is placed in a three-dimensional world. The surface of a desk could be said to be placed on a XY plane, whereas a computer screen could be said to be placed on a XZ plane. Within the literature on visual perception, however, this distinction is not generally considered to be functionally important.

On the other hand, the real difference from XY to XZ may not be 90 degrees, as when using a laptop the screen is normally tilted. In addition, it seems reasonable to assume that images presented on a board screen on a front of a child sitting down at a table may not be different if they are presented on a screen set flat over a table, since the child may adjust his position, by tilting his head forward, to perceive the board at much the same angle (see Figure 4.3).

Figure 4.3: Typical laptop screen versus paper setups.



It should also be highlighted that the subjects of the study, school children, are very accustomed both to tasks presented in front of them, in a vertical plane relative to the floor (in computer tasks), and to tasks presented also in front of them but in a horizontal plane relative to the floor (over their desk), they are familiar with shifting their head position to accommodate both tasks. It seems reasonable to conclude that the display plane to be used in the two versions of the game are not likely to affect the relative perception of the individual.

One final aspect of plane of representations required evaluation.The nature and design of the Noughts and Crosses game presented was symmetrical. Not only was it based on a 3x3 cells grid, but also the symbols used 'O' and 'X' themselves were symmetrical. There were 8 different possible solutions: 2 diagonals, 3 vertical and 3 horizontal. Even if there was a difference in opting for vertical solutions rather than horizontal ones, or vice versa, this would belong to the area of problem solving analysis. As the study presented here was not concerned with the nature of the solutions but rather with the opportunities for interaction and the motivational effect of the outcome, a bias towards any particular type of solution would not have any implications for the experiment design.

In summary, the use of Noughts and Crosses in a conventional computer-based presentation versus a horizontal paper version seemed appropriate for the purposes of this research, given that they are both standard presentations children may encounter, and that a more sophisticated technology might detract from the security and reduce the separation afforded by a traditional computer, making it less attractive to children with ASD.

4.3.4 Pilot study

A small pilot study was conducted during the design of the study with the following aims:

- to identify any problems with the interaction protocol (playing strategies and behaviour pattern).
- to practise the interaction protocol.
- to identify any problems with the computer program.
- to identify any difficulties with the paper version.
- to find out whether the task demands were appropriate for the range of children involved in the study (two primary school teachers consulted had expressed concerns about the motor ability to draw 'O' and 'X', and the cognitive ability to play 'Noughts and Crosses' at 6 years of age).

Pilot Participants

The pilot participants were approached with parental consent. The first one, Child A, was a15 years old typically developing female. The second one, Child B, was a 8 years old typically developing male. The third participant, Child C, was a 6 years old male with a diagnosis of autism. Children B and C were siblings.

Methods

With Child A and B, the session followed this structure:

1. greeting and introduction of the game.
2. child and researcher opposite each other, explanation of the rules, play 15 paper games.
3. child and researcher sitting side by side, play 15 computer games on laptop version
4. researcher questions child about the game and his/her preferences in paper version vs computer version.
5. finish session.

With Child C, the intension was to experiment with the various sitting positions, and the length of the match was reduced to allow for a shorter attention span. The structure was as follows:

1. greeting and introduction of the game
2. child and researcher side by side to learn the rules of the games (played 6 times)
3. child and researcher opposite to each other, play 5 games on the paper version
4. child and researcher side by side, play 5 games on a computer version in a laptop
5. child and researcher side by side, play 5 games on a paper version
6. child and researcher side by side, play 15 games (child was engaged) on the computer version

7. researcher questions child about the game and his preference of the two versions

8. finish session

Observations

Interaction protocol

- It was difficult to give feedback according to script; difficult to say a specific remark for a specific event; difficult to stick to a particular wording.
- Although it was difficult to follow the playing strategies, few mistakes occurred.
- It took an average of 15 minutes to complete a 15 games match, including time to take notes and to consult the interaction protocol sheet.
- The laptop was sometimes a distraction. Child C started playing with the keyboard by the end of the fourth match in a computer-based session, and carried on fiddling with the screen once we had stopped playing.

Social interaction

- More eye contact and verbal exchange were noted with child A and child B when sitting opposite rather than side by side at the computer.
- Different children prompted different behavior from the adult researcher. Child B was highly interactive whereas Child A was the least expressive of the three children when at the computer, and this in turn had a clear impact on the researcher's behavior.

Enjoyment

- With Child A there was less eye contact and even less interpersonal interaction when at the computer, since the speed of the game kept her focus on playing. However, this child did say she had enjoyed the activity and preferred the computer version. It is possible that enjoyment and enjoyment displays may not appear together, and thus lack of observable signs of enjoyment is not a reliable way to judge enjoyment.
- Child C, the child with ASD, showed much more excitement when at the computer and a longer time on task.
- The three participants reported enjoying the game and preferred the computer version.
- None of the children seemed to notice or be bothered by the researcher's playing strategies.

Conclusions

- The interaction protocol needed to be adjusted provide general rules that could be easily remembered and applied consistently.
- Minor modifications to the game program were required.
- Minimum modifications to the paper version were required.
- The speed advantage of the computer version balanced out with playing mistakes, although there were also mistakes.
- Children with ASD as young as 6 years of age appeared able to learn the basic

elements of the game and well enough to enjoy the game.

- Young children with ASD and no motor difficulties should also be able to meet the task demands of both versions of the game.

4.3.5. Study 1: Participants

Access

6 local schools were approached by a letter to the head teacher which outlined the project and its aims (see Appendix D). Four replied positively and one large primary school was selected on the basis of number of potential participants and space availability. The local authority was than contacted for permission to work within the school and, once gained, parents were contacted to seek their permission to work with their children. Parents received a letter, an information sheet with a summary of what was involved in the study, and a consent form (with a copy for themselves) to be returned to the researcher (see Appendix E). All participants were attending a Communication Unit within a Primary school.

It was agreed that the children were going to be informed about the research in advance by parents and teachers, but the researcher also informed them briefly about the goals and methods of the study on the day of the first visit, prior to carrying out the child assessment measures. Although signed consent by children is not required by the authorities and was not requested in this study, if a child did not wish to participate his choice was respected.

Participants were 12 children between 6 and 11 years of age, with a diagnosis of ASD, who had difficulties in communication and social interaction but who were able to become involved in an activity that was not necessarily their preferred one. The children were all familiar with computers or could demonstrate the ability necessary to use them at a very basic level.

Assessment

Teachers were asked about level of computer use for each child as well as any particular individual characteristics that might influence the study. They also completed the social sections of the Vineland questionnaire in order to establish a baseline measure of social competence and interaction skills (Sparrow et al. 1985). The researcher conducted an assessment session of 30 minutes with each child using a short form (set of four subtests) of the Weschler Intelligence Scale for Children (WISC) Third Edition UK to establish their current level of cognitive functionary (Wechsler, 1992).

The main purpose of this assessment was to divide the children into two groups evenly distributed according to age and range of ability (see Table 4.3, over). Given the age range tested and the wide variation in children measures, individual matching was not possible and priority was given to social skills level in matching at group level.

Table 4.3: Group matching.			
Group	Age	Social	IQ
Paper	8:0 (6:10-9:8)	3:0 (1:9-4:6)	64 (52-72)
Computer	8:1 (6:10-9)	2:11 (1:9-4:3)	61 (49-67)
Total Average	8:0 (6:10-9:8)	3:0 (1:9-4:6)	62 (49-72)

Profiles

Participants at the start were twelve boys and two girls, age 6 -10 years, all with a diagnosis of ASD (2 with autism and the rest with Asperger syndrome), all of whom had regular access to computers at school. Two of the boys were identical twins. Table 4.4 provides a detailed profile for each participant.

Table 4.4: Participants' profiles. (Chronological, and social age given in years:months)						
Child	**Diagnosis**	**Age**	**Social**	**IQ**	**Computer use**	**Group**
C1	Asperger S.	9:0	2:10	67	2	Computer
C2	Asperger S.	9:8	2:6	69	2	Paper
C3	Asperger S.	7:3	4:6	72	2-3	Paper
C4	Asperger S.	6:10	3:9	66	1-2	Computer
C5	Asperger S.	8:1	4:3	64	2	Paper
C6	Asperger S.	7:1	2:6	66	1-2	Computer
C7	Asperger S.	6:10	2:7	66	1-2	Paper
C8	Asperger S.	8:4	2:7	59	2-3	Paper
C9	Autism	8:11	1:9	49	4	Computer
C10	Autism	8:9	2:6	53	2-3 times/week	Computer
C11	Autism	7:8	4:3	65	2-3	Computer
C12	Asperger S.	7:9	1:9	52	2-3	Paper

4.3.6 Procedure

All the sessions, including the assessment, took place on the same day of the week, at the same time and in the same place and in consecutive weeks where possible, with scheduling always accommodating to children's timetables to minimize disruption. The experimental sessions took place in an empty classroom with the game on a table, two chairs side by side, about a foot apart, and a video camera in front, two meters away. Children sat at the right side of the table and played Noughts and Crosses with the experimenter for 15 minutes.

The experimenter met the children at their classroom and walked them to the testing room. After welcoming them and inviting them to sit down, she introduced them to the activity and asked them if they knew the game. Then they would be prompted to start playing the first game with the researcher. Then time was up, they were asked if they had enjoyed playing before taking them back to their classroom.

The following protocol was designed trying to maximize opportunities for interaction and engagement of the child during the sessions, taking into consideration the findings of the pilot trial described earlier:

- Game strategy:
    - lose or tie in the first 3 games
    - then try to win, tie, lose, in sequence; (while allowing for mistakes and the nature of the game to vary the sequence as necessary)
    - modify this as necessary to ensure engagement during the match and that the child wins at the end

  For a detailed description of this strategy, see Appendix F.
- Interaction pattern:
    - praise or encouragement at the end of each game (more frequently in first 4-5 games)
    - state child is still winning overall when experimenter wins a game if he/she seems upset
    - use trouble shooting list (see Appendix G) if:
        - child does not want to play
        - child goes off task
        - child shows frustration after losing a game
        - child plays but does not seem to understand
        - child does not want to give up pen/mouse
    - follow any interaction initiated by child (but then lead him/her back to task)
    - hand in mouse or pen (pen, to the hand, mouse, move to child's side)

When there was a conflict between following the protocol strictly and reacting naturally, the latter was given priority as helping interaction to flow was the focus of the experiment, not sticking rigidly to a protocol. A more detailed script of this protocol can be found in Appendix G.

4.3.7 Video Analysis

All the sessions were recorded using a digital video camera set 2 meters away from the players allowing a close view of the child but also capturing the adult. It had been anticipated that the camera might cause unease in the child or be a distraction but although most of the children noticed the camera and some asked about it, only one was distracted by it, and only occasionally. Only the sessions of 10 of the initial 12 participants could be analysed as technical problems resulted in two of the video records being incomplete. Both 15 minute sessions, with the computer and paper versions of Noughts and Crosses, were recorded, providing 20 video of child- researcher interactions.

The software used was Noldus Observer Video-Pro 5, a video analysis package that allows frame-by-frame analysis of digital video files and also contains a basic statistical tool. The 20 sessions were reviewed using a continuous sampling analysis in order to capture all of the behaviors taking place; as some of the behaviors took place infrequently, these could have been missed if coding had taken place only at set intervals. Sessions were analyzed in a random order to avoid coding according to expectations. Using Observer, only one behavior of the same category can be taking place at any given time, thus when a particular event takes place, it has to be keyed in at the beginning and at the end. Any co-occurring behaviors falling into a different category are coded in in the same way, with the segment of tape reviewed as often as is necessary.

The research questions required observing the frequency and duration of all of the social behaviors of the child, including when he was responding or initiating interaction. The coding scheme adopted was an adaptation of Willis et al. (in prep.). This had been designed to observe interaction between two children with learning difficulties during a collaborative-play task. The suitability of Willis' original categorization system was piloted by analyzing a five minute interval of two very contrasting video sessions in order to see whether behavioral categories would need to be adapted, given that, in this study, the child's partner and the researcher were the same person, and that the collaboration took place in a very structured setting, as opposed to the flexible setup in Willis et. al. (in prep.).

The behaviors finally defined were:

- *On-task independent*: the subject was performing the task on his own, e.g. selecting the cell in which to place Noughts and Crosses.
- *Off-task independent*: the subject displayed a non-task related behavior on his own, such as standing up, or looking away.
- *On-task social*: the subject displayed a task related behavior towards his partner: e.g. looking at, talking to, or turning towards experimenter.
- *Off-task social*: the subject displayed a non-task related behavior towards his partner, such as an off-task conversation.
- *Watching*: the subject was looking what the experimenter was doing (other than playing), e.g. writing down results.
- *Unclear*.
- *Off-camera*.

The first four behaviors were further defined by two modifiers that described whether they were spontaneous, (i.e. initiated by the subject) or a response to the partner's behavior, and whether they were verbal or physical.

A second observer blind to the purpose of the study scored 10 % of the 20 videotapes. There was 70% agreement on the frequency of codeable behaviours, with a higher agreement in relation to the duration of behaviours, 95% (see Table 4.5). According to Cohen (1960), a kappa > .70 is acceptable, and although the frequency is below this mark, the duration well above that.

Table 4.5 Inter-observer reliability.				
	% agreement frequency	kappa	% agreement duration	kappa
Total behaviours	70	0.58	95	0.90

4.4 Results

The essential questions the study tried to answer all related to the level of engagement and interaction displayed under the two different game conditions. This section therefore presents the findings regarding On-task and Off-task behaviour, Spontaneous and Response behaviour, as well as exploring how these related to the number of games played. As an initial analysis of the data showed similar profiles for the frequency and the duration of the behaviours under study and given that most behaviours being coded were brief in duration, analysis by frequency was considered as a suitable and sufficient basis on which to conduct a more detailed analysis of child behaviours.

4.4.1 General results

On-task behaviours

As can be seen in Table 4.6, mean frequency of Total On-task behaviour of 169 in the paper version of the game and 139 in the computer version, a difference which proved to be statistically significant ($t(9)=4.016$, $p=.003$). This difference was driven by frequency differences in the Computer group, which started the experiment with the computer-based version of the game (178 in the paper session vs. 136 in the computers session); this difference was significant ($t(4)= 5.713$, $p<.005$), while the difference in behaviour across conditions in the Paper group results was not significant.

Table 4.6: On-task behaviour frequencies.							
		Total On-task		On-task Social		On-task Independent	
Group		Paper session	Computer session	Paper session	Computer session	Paper session	Computer session
Paper first	Mean	160.8	141.4	62	50.6	98.8	90.8
	Std. Deviation	32.7	44.6	30.1	37.8	9.7	10
Computer first	Mean	177.8	136.0	70.2	51.4	107.6	84.6
	Std. Deviation	44.4	35.3	23.4	22.1	24.9	16.5
Total means	Mean	169.3	138.7	66.1	51	103.2	87.7
	Std. Deviation	37.8	37.9	25.8	29.2	18.5	13.3

These differences in Total On-task behaviour could have been due to either Social and/ or Independent On-task behaviours. Statistical analysis showed that the differences between paper and computer sessions (see Total Means in Table 4.6) were significant in both cases: On-task Social ($t(9)= 3.601$, $p=.006$), On-task Independent ($t(9)= 3.761$, $p=.004$). Not only was On-task Social behaviour more frequent in the paper version (66) than in the computer version (51) but so this was On-task

Independent behaviour (103, 88). Yet again, the difference was driven by the computer group, (On-task social: t(4)= 4.414, p=.012; On-task Independent: t(4)= 4.960, p=.008) while the paper group did not show significant difference. Table 4.5 also shows that On-task Independent behaviour was more frequent than On-task Social behaviour, a difference which can be explained by the inherent nature of the task.

These analyses all showed significantly greater interaction occuring under the paper condition than at the computer. Although this might indicate that the paper condition was more conducive to interaction, the data could also be analysed by taking into consideration the order of the experiment. The Paper group started the experiment with the paper version of the game, and the Computer group started with the computer version. The Total On-task behaviour on the Paper group decreased from a mean of 161 in the first condition (paper) to 141 in the second (computer), whereas in the Computer group this kind of behaviour increased from 136 to 178 over successive conditions. This could be taken as indicating that the computer was a positive predecessor of a paper-based version, since there was more interaction in the paper condition following the use of the computer than when this was the first of the two versions presented. A reason for this could be that the computer allowed the child to relax more with the partner, which lead to being more interactive later on. However, it would not possible to make any claims in this regard due to the small number of subjects studied.

It is also necessary to highlight the great variability among subjects, specially in the On-task Social behaviour, where the standard deviation for the paper session (mean: 66) was 26 and for the computer session (mean: 51) was 29. This was more acute within the Paper group, with a mean of 62 and standard deviation of 30 in the paper session, and a mean of 50 and standard deviation of 38 in the computer session. Since both groups were matched in chronological, cognitive and social age, these differences should be due to the medium rather than the individuals, but there groups are too small to assert that starting with the paper version of the game generated more variability in the levels of interaction.

Off-task behaviours

Table 4.7: Off-task behaviour frequencies.

Group		Total Off-task		Off-task Social		Off-task Independent	
		Paper session	Computer session	Paper session	Computer session	Paper session	Computer session
Paper first	Mean	24.4	12.4	3.6	2.4	20.8	10
	Std. Deviation	25.5	7.3	5.4	1.8	20.5	7.1
Computer first	Mean	21.2	38.4	9.2	20.8	12	23.4
	Std. Deviation	30.1	41.0	15.6	32.0	14.8	30.8
Total mean	Mean	22.8	25.4	6.4	11.6	16.4	16.7
	Std. Deviation	26.4	31.0	11.4	23.5	17.5	22.2

There were no significant differences in Off-task behaviours related to order of presentation, either in total or when these were subdivided into Off-task Social and Off-task Independent behaviours. The data followed a pattern worth mentioning, however. As Table 4.7 shows, although the mean frequency in the paper session (23) was similar to the computer session (25), the standard deviations were 26 and 31 respectively; these are greater than the actual means, showing again, a great variability among individuals. Likewise, although the Total means were similar for the two groups, the difference in frequency of off-task behaviours while at the computer was very large in the two groups (Paper group =12, Computer group = 38). This meant in effect that the Paper group was less Off-task at the computer and the Computer group was less Off-task with the paper version.

When looking at the order of the sessions, the mean frequency dropped from 24 to 12 in the Paper group, and from 38 to 21 in the Computer group, which indicated that Total Off-task behaviour was greater when starting at the computer than when starting on the paper version, but also that this behaviour decreased after the second session, making familiarity a possible explanation for these changes in frequency of off-task behaviour. The key element on which the two groups were the most different was Off-task Social behaviour, where the mean frequency of the Paper group in the first session (paper) was 4.6 and in the first session of the Computer group (computer) was 21.

A pattern similar to that found in the analysis of On-task behaviours also appeared when looking at the Off-task Social behaviour in isolation. This behaviour was less frequent than Off-task independent, implying that the majority of the Total Off-task behaviour was driven by the independent activity. While that held true for the Paper group, Off-task Social and Independent behaviours were similar for the Computer group (23 and 21 respectively), however.

It has to be pointed out that these Off-task behaviours were less frequent overall than the On-task behaviours. This at the level of the individual together with the variability seen (as evidented in standard deviations) make it necessary to look at results to understand the interactions that were taking place.

Spontaneous Social behaviours

Table 4.8: Spontaneous Social behaviour frequences.

Group		Total Spontaneous		On-task Social Spon.		Off-task Social Spon	
		Paper session	Computer session	Paper session	Computer session	Paper session	Computer session
Paper first	Mean	53.2	46.8	37.2	39.6	16	7.2
	Std. Deviation	29.4	39.5	21.2	34.8	22.7	12.1
Computer first	Mean	65.8	59.0	48.0	40.0	17.8	19
	Std. Deviation	9.2	24.2	20.4	21.3	24.2	29.2
Total mean	Mean	59.5	52.9	42.6	39.8	16.9	13.1
	Std. Deviation	21.6	31.6	20.4	27.2	23.5	20.6

Table 4.8 shows the Total Spontaneous behaviour (paper = 59, computer = 53), the On-task Social

Spontaneous behaviour (paper = 42, computer = 39) and the Off-task Social Spontaneous behaviour (paper = 17, computer = 13). Again, there were no significant differences across experimental conditions with respect to frequencies of Total Spontaneous social behaviour, nor in the On-task or Off-task social behaviours. From a descriptive point of view, there was a trend towards a slightly higher frequency in the paper condition than in the computer condition, in line with the results on the behaviours presented previously.

Due to the low frequency of Off-task behaviours, it would allow that the Total Spontaneous behaviour was driven by the On-task Social Spontaneous. In respect of order effects, it appeared that there was a slightly higher increase in On-task social Spontaneous when starting at the computer (from 40 to 48) than when starting with the paper version (from 37 to 39). As with previous behaviours, however, there was a great variability in frequency across children, as shown by the standard deviations, pointing again at the need for individual analysis.

Response Social behaviours

A similar pattern appeared in the On-task Total Response behaviours (see Table 4.9): although there

Table 4.9 Response Social behaviour frequencies.

Group		Total Response		On-task Social Res.		Off-task Social Res.	
		Paper session	Computer session	Paper session	Computer session	Paper session	Computer session
Paper first	Mean	20.0	11.8	19.6	11.0	0.4	0.8
	Std. Deviation	8.0	4.6	8.6	5.7	0.9	1.9
Computer first	Mean	19.2	17.0	17.6	11.4	1.6	5.6
	Std. Deviation	9.0	9.7	8.8	4.2	2.7	11.4
Total mean	Mean	19.6	14.4	18.6	11.2	1	3.2
	Std. Deviation	8.0	7.6	8.3	4.7	1.9	6.6

was not a significant difference overall between conditions (mean frequencies were 20 in paper session, and 14 in computer session), the Paper group's production of this kind of behaviour decreased from a mean of 20 to 11, while the Computer group's rose from a mean of 17 to 19 over successive conditions. This behaviour was clearly driven by the On-task Social Response component which showed a significant difference ($t(9) = 2.619$, $p = .028$) between the two sessions, making it clear that children were more responsive in the paper session.

The infrequency of the Off-task Responsive behaviour, together with the great variability made it difficult to draw any conclusions, but indicated that certain individuals were possibly displaying behaviours that differed from the pattern of the general results.

On-task Social Spontaneous behaviour

Table 4.10 shows the On-task Social Spontaneous behaviour decomposed in to verbal versus physical behaviours. Although there were no significant differences, it is very clear that verbal behaviours were at least three times more frequent than physical behaviours. Looking specifically at the verbal behaviour, it appeared that there was more of this behaviour in the paper session (43) than in the computer session (36). However, those who started with the computer version showed a large increase (35 to 48) whereas frequency of production was more even across sessions in those who started with the paper version of the game (37 and 36). This could be interpreted as the computer session having a positive influence on On-task interactions following sessions.

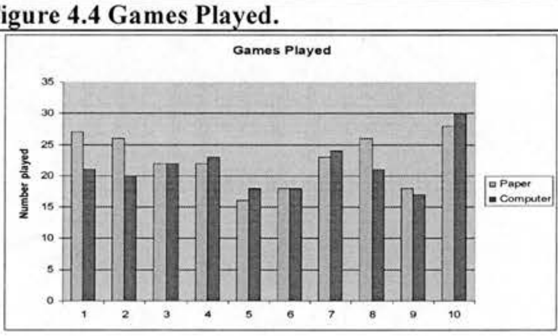
Table 4.10: On-task Social Spontaneous behaviour frequencies.

		Verbal		Physical	
Group		Paper session	Computer session	Paper session	Computer session
Paper first	Mean	37.2	36.8	10.8	9.4
	Std. Deviation	21.2	33.8	11.6	9.4
Computer first	Mean	48.0	35.4	14.2	10.2
	Std. Deviation	20.4	21.9	3.6	5.4
Total	Mean	42.6	36.1	12.5	9.8
	Std. Deviation	20.4	26.9	8.3	7.3

Games played

Figure 4.4 displays a graph with the number of games played by each child, generated from the data shown in Table 4.11.

Figure 4.4 Games Played.



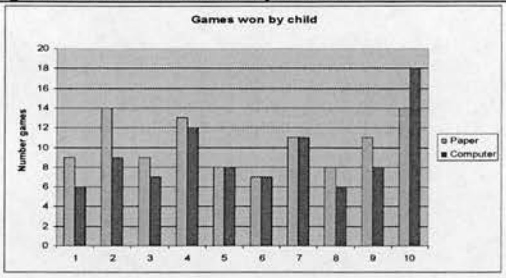
child

Table 4.11: Games Played.

Child	Paper	Computer
1	27	21
2	26	20
3	22	22
4	22	23
5	16	18
6	18	18
7	23	24
8	26	21
9	18	17
10	28	30
Mean	22.6	21.4

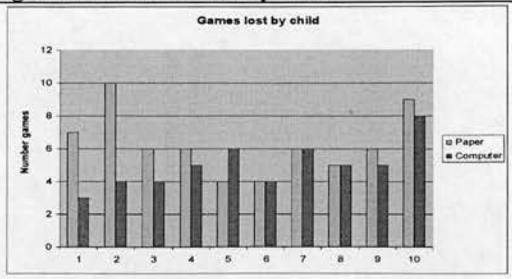
Statistical analysis showed that there was not a significant difference between the conditions in terms of the number of games played, won and lost (see Figures 4.5 and 4.6/for Games Won and Lost). The fact that the means of games played are very similar (22, 21) adds weight to the claim for equivalence of both versions, indicating that the protocol was effective in giving all children the same opportunities to perform at their own level under each condition of playing. Furthermore, the number of games played by all children ensured a similar exposure to interaction based on the feedback and turn-taking derived from each game played.

Figure 4.5 Games won by child.



child

Figure 4.6 Games lost by child.



child

Correlations

Data were analysed in order to find out whether there were correlations between the adult's behaviour, the game, the children's profiles and their interactions with the researcher. The analysis showed no correlations between the number of games played, won or lost in relation to age, cognitive level or social skill level. It might have been expected that children with higher cognitive levels would have performed better than children with lower cognitive levels. The fact that there was no correlation, however, might be due to the protocol of the experiment, which required the researcher to match the child's game level, whenever possible, to maximize and maintain motivation, e.g. allowing the child to win where this seemed necessary/ appropriate.

There was no correlation between the number of games played, won or lost overall with On-task social behaviour. This again might be explained by the protocol, which provided opportunities for interaction in the form of help and feedback, thus, whether playing fast or slow, winning or losing, there was always some level of social exchange.

Equally, analyses did not show correlations between age, cognitive level or social skill level, and On-task social behaviour. When looking at data in more detail, however, there was a significant correlation (r=.783) between age and On-task Social Spontaneous behaviour during the second session. This isolated case would be difficult to explain, since the same correlation did not appear in the same behaviour during the first session, or another for sub-category of this kind of behaviour, such as On-task Social Response, during the second session.

It might have been expected that the adult behaviour had an influence in the child the final analysis carried out did not find a correlation between Adult On-task Social Spontaneous behaviour and the children's On-task Social behaviour, either spontaneous or responsive, however. No one factor can thus be singled out as being crucial in influencing the children's level of social interaction.

Overview of findings at group level

The significant difference found in On-task behaviours under the two conditions of game playing could be interpreted in different ways. It is possible that the paper version was more conducive to On-task Social interactions (means totals: paper session= 169, computer session=139), with the paper version producing the higher frequency values regardless of the order in which it was presented. It is also possible that experiencing the computer version first may prompt more of the desired behaviour in the next session: e.g. in Table 7.1, On Task Social behaviours, clearly increased in frequency (from 51 to 70 when this was given first), as opposed to the slight decrease seen in the paper-first condition (frequency from 62 to 50).

Another possibility is that children were more focused on the screen and thus in the computer version less talkative, unless they get stuck, in which case they would need help. In practice, some children shared their own strategies with the researcher, or their joy for winning, so it was not possible to totally control this element of interactions. In addition, the specific game selected was chosen, among other reasons, because it was simple enough that children could play it even if they did not understand winning strategies. The protocol made sure they still won as many matches as other children with more playing skills.

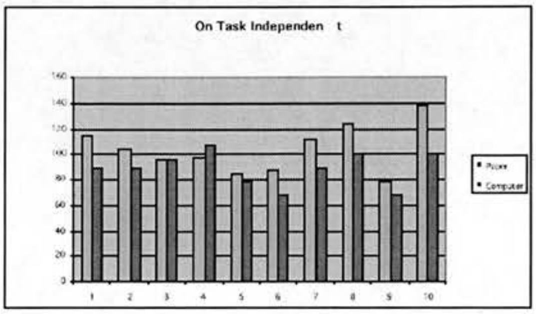
On the other hand, the sizes of the standard deviations within these data, especially in the On- and Off-task Social (see Tables 4.6 and 4.7), indicate wide individual variability in interaction profiles and this clearly impacted on group level in verbal interchanges. One of the factors underlying this wide variability could be that some of the children had very distinctive interests which had differing opportunities to manifest themselves during the sessions. For example, one child had more verbal interest that could be displayed in any setting. In order to maintain motivation, another child was allowed time to draw an 'interest specific' version of the noughts when it was his turn, , but this allowance could not take place in the computer version. In this latter case, what may appear as being more focused on task, could be that the child was active with an off-task behaviour (this was taken into consideration when analysing the video). All these made it necessary to look at the individual data.

With respect to game-playing, the lack of significant differences in the number of games played by the children in either the paper or computer version could indicate that both versions of the game provided equal opportunities to engage in play, adding evidence to the case of their equivalence. The lack of significant difference in the number of games won or lost by the children in either the paper or computer version was based on the game plan defined in the protocol, allowing some degree of confidence that the game strategy script designed was being followed closely by the experimenter in both conditions.

4.4.2 Individual results

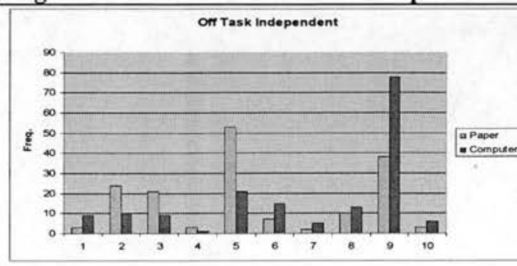
The following figures display graphs of frequency data for each participant for each of the categories of behaviour under study in which the Paper group children are re-named as subjects 1 to 5 and the Computer group children are subjects 6 to 10.

Figure 4.7: Children On-task Independent.



child

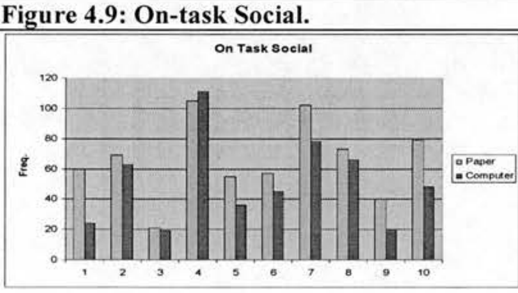
Figure 4.8: Children Off-task Independent.



child

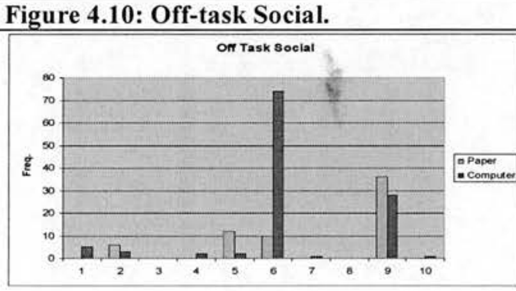
Figure 4.7 presents a fairly homogenous distribution of On-task Independent behaviours, across the two groups and within each individual across the two conditions. Subjects 1 and 2 showed more of this behaviour in the paper version, as well as subjects 6, 7, 8 and 10, who started with the computer version. In contrast, Figure 4.8 shows a clear distinction among subjects, with respect to Off-task Independent behaviour: subjects 5 and 9 were Off-task more than the rest, the first in the paper version and the second in the computer (in both cases, the first condition encountered). Furthermore, subject 9 displayed the least On-task Independent behaviour of all participants in both conditions.

Figure 4.9: On-task Social.



child

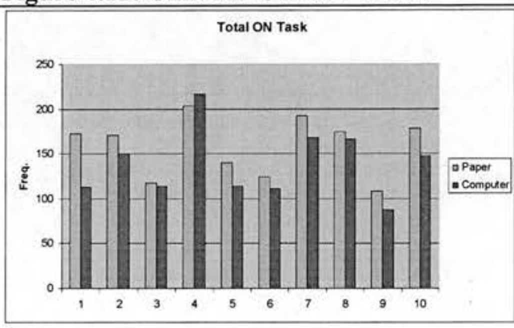
Figure 4.10: Off-task Social.



child

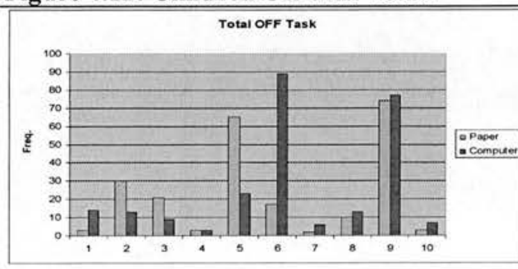
The On-task Social behaviour frequencies (Figure 4.9) shows considerable variation among participants, but a good degree of consistency in behaviour within participants across the two conditions: e.g. those who were the least interactive were so in both conditions and those who were the most social interactive, maintained this level of interaction in each session. The most marked differences occurred with subjects 1 and 10, who displayed more On-task social behaviour when playing on paper rather than in the computer. Interestingly, subject 6 showed the highest level of Off-task Social behaviour with the computer version (see Figure 4.10), despite showing very similar levels of On-task behaviour to subject 5. Subject 9 appeared to be very interactive Off-task as well, with a slightly greater frequency in the paper version, the same one he was more frequently On-task in (although not in comparison to most other children).

Figure 4.11: Children On-task Total.



child

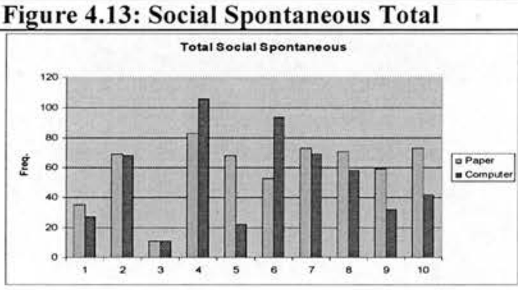
Figure 4.12: Children Off-task Total.



child

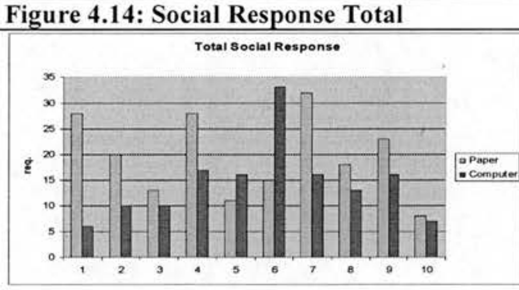
On grouping the previous data together, the Total On-task behaviour (Figure 4.11) seemed to be homogeneous for both groups of children and also within each subject across conditions, the one exception being subject 1, who seemed clearly more On-task on paper. The grouping of the Off-task behaviours showed that subject 5 was very much Off-task in the paper version, subject 6 in the computer version, with subject 9 equally Off-task in both versions.

Figure 4.13: Social Spontaneous Total



child

Figure 4.14: Social Response Total



child

Finally, Figure 4.13 shows Total Spontaneous behaviour within both sessions, again indicating that the majority of individuals were relatively consistent in levels of this behaviour in both versions of the game. Subjects 9 and 10 displayed proportionally more Spontaneous behaviour in the paper version whereas subjects 4 and 6 did so at the computer. In the same vein, subjects 1, 2, 4 and 7, and to a less extent, subject 9, were more responsive in the paper version. Subject 6 showed the opposite pattern, being much more responsive at the computer (see fig. 4.14).

Overview of individual findings

Analyses of the data at the individual level showed that individual differences clearly need to be considered in interpreting the findings of this first study. While it was difficult to draw general conclusions, it was clear that different versions of the game had a different effect in some individuals. For example, for subject 5, both conditions seemed to produce much the same kind of pattern behaviours: he was more On-task, more Spontaneous as well as more Off-task in the paper, but he was more responsive at the computer. On the other hand, subject 6, who was more interactive (and especially responsive) during the computer version, was slightly more On-task Social on the paper version, but displayed more Social Spontaneous, Off-task and Off-task Social behaviours at the computer. Subject 9, by contrast, presented a mixed profile: he displayed a little more On-task Social (Spontaneous and Response) behaviours in the paper version, but was the child who produced the most Off-task behaviours overall, and in both versions of the game.

These individual cases show that some children may do better at the computer whereas others may do better with a paper based activity. In looking at each variable it is possible to see that for the majority of children there seems to be no great difference in behavioural responses whereas there are typically , two or three subjects who each have different responses. This is consistent with the general belief among experts that specific interventions each seem to work for only 20% of the ASD population, indicating the need to find out what works for which individual and what does not (Jones, 2003).

On another note, all of the 12 children tested here seemed to enjoy the experience and engaged well with the computer game, despite of its lack of multimedia features. This, however, was the subjective impression of the experimenter and although in line with what teachers reported for these children, as Crook (1994) has demonstrated, each personal judgements may not be accurate. He reported on a study of the use of a computer-based activity that introduced some mathematical skills, in which the teachers thought children were learning because of their high levels of engagement with the computer. While the teachers considered the activity helpful, the researcher's data showed that it was not. In the same study, when a teacher included the computer-based activity into the classroom (e.g: blackboard examples based on the activity), the students learned more. The implications were that the potential of computer-based instructions would be better realised if it were integrated with the rest of the classroom life, and not as a separate entity. This is particularly important in the area of social skills development in children with ASD if the skills learned at the computer are to be transferred to other areas of the child's life.

Although children's enjoyment during the experiment was a subjective perception of the experimenter, there are anecdotal accounts reflecting the fact that a majority of children with ASD do enjoy using computers (see Chapter 2). Even if the game activities around computers were not as effective as paper based activities in fostering social interaction, they still provided an enjoyable starting point for children with ASD who cannot initially cope with other forms of shared play, starting to build a friendship they could develop and carry forward to other contexts, outside of the computer environment.

Summary

Results were not conclusive, but suggested some differences between the two game mediums. The overall data showed:

- significantly more On-task Social behaviour (including Spontaneous) in the paper version.
- the highest frequencies in On-task Social behaviour (including Spontaneous) when the paper-based sessions were preceded by the computer-version.

There was, however, considerable individual variability in individual profiles of behaviours.

The individual data showed:

- some individuals were more interactive with the paper version.
- some individuals were more interactive with the computer version.
- some individuals were more on task social with the computer version and more off task with the paper.
- some individuals were more on task social with the paper version and off task with the computer.
- some individuals were more on task and off task social with the computer version.

The number of games played showed:

- both versions of the game provided equal opportunities to play
- the game strategy script as designed could be followed closely by the experimenter.

4.5 Conclusions

The main aim of this study was to design and evaluate a computer version of a paper-based game. The data showed the two versions of the game to be equivalent and the main finding was that, in general, the majority of the tested children were more focused on the task and more interactive in the paper version of the game, although some individuals interacted more when playing at the computer. It could not be concluded that computers were detrimental to engagement for children with autism as all the children displayed on task social behaviours while at the computer and indeed there are several arguments that could be made in support of the use of computers with this group of children. However, having seen that play allows children to experiment with roles and interaction, (Restal and Magill-Evans, 1994, see also section 1.3, p.21), the potential of computer games in social interaction (discussed in section 2.3.2, p.42-43), and that some games are more conducive to interaction than others (Friedman, 1995), the study prompted more questions such as: Does the nature of the game, being competitive play a role in interaction? The studies reported in the next chapters tried to answer those questions.

Chapter 5: Social interaction in individual vs. partner playing

This chapter presents a second study which observed the social interaction process during computer play of Noughts and Crosses. In this study the child with autism played with (against) an adult partner and alone. The aim was to find out if playing against a human opponent played a different role in the interaction in comparison to playing alone when the amount of adult feedback was held constant across the two conditions of play.

5.1 Research questions

The present study was designed to explore the role of a playing partner in the interaction and to find out whether and how might affect children's attention and interactions. In particular, it was intended to find out whether playing with a partner created more opportunities for social engagement, whether the child was engaged in more and longer interactions, and whether more child-initiated interactions occurred than when the partner was only providing praise and feedback. The specific research questions were therefore:

1. Engagement:
   - Does the child engage more in the game when playing individually against the computer versus against a partner?
   - Does he remain focused on task longer?
2. Interaction:
   - Does the child respond more to the adult present when playing directly against him?
   - Does he initiate more interactions considering that the adult is there to encourage the child when playing individually?

To answer these questions, the child and researcher carried out an activity jointly, playing Noughts and Crosses against the computer, as the outcome of the child playing alone with the computer version of the same game, as described in chapter 4.

5.2 Methodology

5.2.1 Overview

Nine children of primary school age with a diagnosis of ASD participated in the study, which was carried out at the children's school. The activity was playing 'Noughts and Crosses' against the researcher in a computer in a first session, and against the computer, with the researcher by their side, in a second session. The sessions were led by a predefined protocol including a script of the researcher's behaviour and playing strategies when needed.

5.2.2 Study Participants

The participants were the same children who participated in study 1, presented in Chapter 4 (see section 4.3.5, p.101) with the exception of one child who had moved to another school. They were 7 boys and 2 girls between 6 and 11 years of age, with a diagnosis of ASD and difficulties in communication and social interaction but with no significant cognitive impairment.

5.2.3 Access

Access to children for this study was granted on the basis of the earlier contact and consents, as a continuation of the same body of research.

5.2.4 Procedure

The experimental sessions took place in an empty room with the laptop on a table, two chairs side by side, about a foot apart, and a video camera facing the chairs, two meters away. Children sat at the right side of a table and played Noughts and Crosses against the experimenter or against the computer for 15 minutes under each condition.

The general procedure was as described in Chapter 4 (section 4.3.6, p.102), but this study required some modifications on the game. In order to allow the child to play against the computer, the game used in the previous study had to be reprogrammed and the playing strategies described in Appendix F implemented. An algorithm from Vine (2002) was adapted to ensure that the computer did not try to win every match, thus allowing the child to maintain motivation.

The following protocol, presented in Chapter 4 (section 4.3.6, p.102) and described in more detail in the Appendix G, was used to maximize opportunities for interaction and engagement of the child during the sessions, with the game strategy used only when the child was playing against the experimenter:

- Game strategy:
  - lose or tie in the first 3 games.
  - then try to win, tie, lose, in sequence; (but taking account of the fact that child mistakes and the nature of the game might vary the intended results in anyone game)
  - modify this strategy to ensure engagement during the match and that the child wins overall by the end.
- Interaction pattern:
  - praise or encouragement at the end of each game for the first 4-5 games then every 2-3 thereafter.
  - state child is still winning when experimenter won one if he seemed discouraged/ upset.
  - follow any interaction initiated by child (but then lead him back to task).
  - exchange mouse.

Minor variations to this protocol took place in order to maximize motivation and to make the experimenter's behaviour appear as natural as possible.

5.2.5 Video Analysis

All the sessions were recorded using a digital video camera set 2 meters away from the players in order to have a close view of both the child and the adult. The software used to do the analysis was Observer Video-Pro. The videotapes were analyzed in a random order to avoid coding according to expectations. The procedure and coding scheme adopted was the same as in study 1, as described in Chapter 4 (see section 4.3.6 and 4.3.7, p.103).

A second observer blind to the purpose of the study scored 10 % of the 18 videotapes. There was a 75% of agreement in the frequency, with a higher agreement in the duration, with 95% (see Table 5.1 below).

Table 5.1 Inter-observer reliability.

	% agreement frequency	kappa	% agreement duration	kappa
Total behaviours	75	0.65	95	0.91

5.3 Results

This section presents findings for On-task and Off-task behaviours, and for Spontaneous and Responsive behaviours. An initial analysis of data indicated a different pattern of results depending in whether frequency or duration of behaviours was the unit of analysis, making it necessary to analyse both types of data. The sessions where the child was playing against the computer are referred to as Alone and those where the child played against the experimenter as Partner. Frequencies measure the number of occurrences of a given behaviour whereas Duration reflects the total number of seconds for that behaviour.

5.3.1 General results

On -task behaviours

There was a significant difference between the two experimental conditions in On-task Total behaviour in terms of both frequency ($t_{(9)}$ = 2.562; p= .034) and (duration ($t_{(9)}$= 14.762; p< .000). These values were probably driven by On- task independent behaviour, with $t_{(9)}$ = 3.311 (p=0.009) for the frequency and $t_{(9)}$= 7.694 (p< .000) for the duration. There were no significant differences in On-task Social behaviour in relation to either frequency or duration for the two conditions, although, as Table 5.2 (below) shows, there were slightly more On-task Social behaviours, when the child played against a partner.

Table 5.2: On-task behaviour

		Total (Ind + Soc)		Social	
		Alone	Partner	Alone	Partner
Frequency	Mean	91	150	41	51
	Std. Deviation	56	42	27	29
Duration	Mean	746	343	67	71
	Std. Deviation	264	146	45	49

From Table 5.2, it would appear that the Partner version provided a better environment to be on task in terms of frequency (150 versus 91) but not duration of On-Task behaviour. However, when looking at the duration of the behaviours, the mean was 746 seconds in the Alone version, for 343 in the Partner version. This implies that in the Alone version behaviours were less but lasted longer, and likewise, in the Partner version, behaviours were more frequent and brief.

Off- task behaviours

Table 5.3 shows the total frequencies- durations of Off-task behaviours in Study 2, comparing these for the two conditions of play. There were no significant differences between conditions for Off-task Behaviours.

Table 5.3: Off-task behaviour frequency vs duration

		Total (Ind + Soc)		Social	
		Alone	Partner	Alone	Partner
Frequency	Mean	9	25	5	12
	Std. Deviation	6	31	6	23
Duration total	Mean	45	75	12	28
	Std. Deviation	30	126	14	56

Although differences were not significant, the values shown in Table 5.3 show more Off-task behaviour in the Partner condition, both overall and under both conditions, with a similar pattern in respect to durations. As the standard durations show, however, here the great individual variability in these behaviours shown by the standard deviations (with SD almost twice the mean value), for example, in the case of frequency of social Off-task behaviour in the partner conditions. It is also worth noting that Off-task behaviour was both less frequent and sorter in duration than On-Task behaviour, indicating that the task was engaging.

Spontaneous social behaviours

Looking at Total Spontaneous Social behaviour (see Table 5.4), there was again a significant difference between the conditions: $t_{(9)}= 6.73$ ($p< .000$) for frequency, and $t_{(9)}= 5.813$ ($p< .000$) for duration values.

Table 5.4: Spontaneous Social behaviour					
		Total (On + Off)		On-task Social	
		Alone	Partner	Alone	Partner
Frequency	Mean	36	53	31	40
	Std. Deviation	22	32	22	27
Duration total	Mean	63	85	52	56
	Std. Deviation	40	71	36	43

Table 5.4 shows clearly that there were more Spontaneous social behaviours in the Partner condition overall (53 versus 36) and similarly, that there were more occurrences of On-task social behaviour (40) in the Partner condition than in the Alone condition (31) although mean duration was broadly equivalent.

Responsive social behaviours

There were no significant differences between conditions in relation to the Responsive social behaviours. Values were very similar across conditions, as well as being low, both in terms of frequency and duration, as can be seen in Table 5.5.

Table 5.5: Responsive social behaviour (frequency vs duration)					
		Total (On + Off)		On-task Social	
		Alone	Partner	Alone	Partner
Frequency	Mean	11	14	10	11
	Std. Deviation	6	8	6	5
Duration total	Mean	17	20	15	14
	Std. Deviation	10	15	10	10

On -task Spontaneous social behaviour

Looking at Spontaneous behaviours in greater detail, there were no significant differences between the conditions in terms of physical versus verbal behaviours.

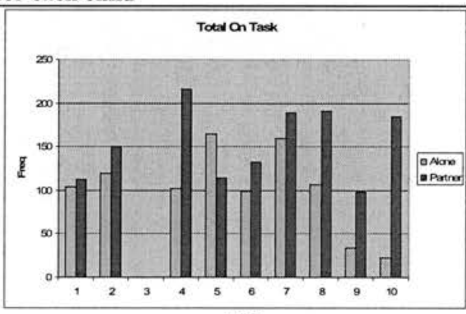
Table 5.6: On -Task Spontaneous social behaviour					
		Verbal		Physical	
		Alone	Partner	Alone	Partner
Frequency	Mean	51	36	7	10
	Std. Deviation	35	27	9	7

As Table 5.6 shows, children displayed three times to seven times more verbal than physical social behaviours in both conditions, with the Alone condition having a mean of 51 verbal behaviours and the Partner condition 36. The small number of occurrences of physical social behaviour together with the variability shown by the standard deviation does not allow meaningful comparisons across Partner and Alone conditions.

5.3.2 Individual results

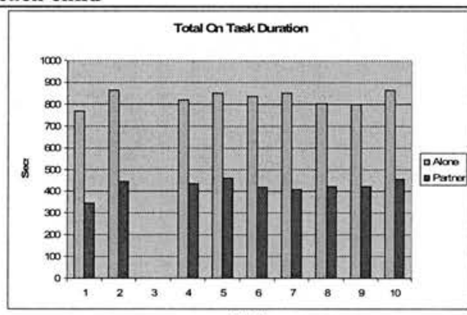
The fact that many differences in the behaviours analysed were not significant but that the standard deviations were very large in some cases, suggest that it might be useful to look at the data at the individual rather than group level. The following tables present graphs for the 9 study participants, with subject number 3, represented as having zero values throughout. This presentation has been chosen because the participants were the same as presented in Chapter 4, and are identified by the same numbers here.

Figure 5.1: On -task Frequency by condition for each child



child

Figure 5.2: On -task Duration by condition for each child

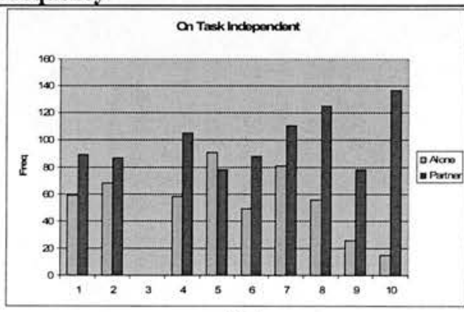


child

Figure 5.1, Total On-task behaviour, shows first, the variability across individuals in the Alone condition, but also that, with only one exception, all children produced more On-task behaviours in the Partner condition. Interestingly, none of these appear when looking at the Duration of the Total

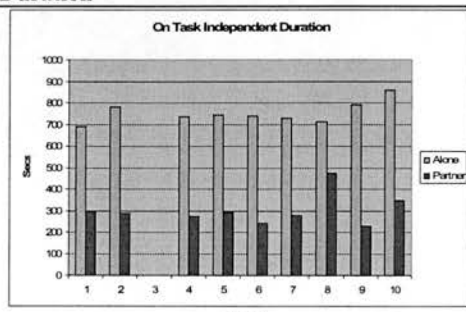
On-task Behaviour (Figure 5.2), where all individuals seemed to display very similar amounts of time On-Task within each condition, with total time On-Task far greater in the Alone condition.

Figure 5.3: Children On-task Independent Frequency



child

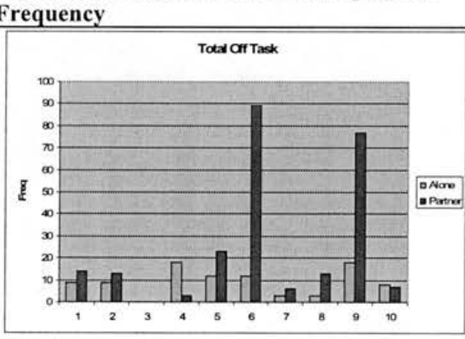
Figure 5.4: Children On-task Independent Duration



child

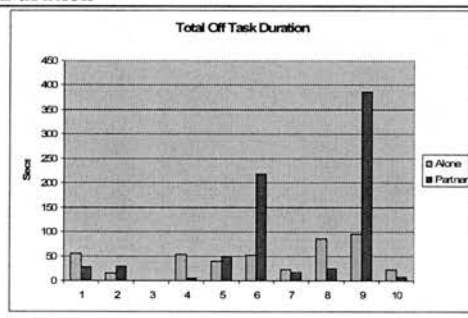
The values of the Total On-task behaviours appeared to be driven by the On-task Independent behaviours. Figures 5.3 and 5.4 show a similar pattern to figures 5.1 and 5.2 respectively, with the most striking difference in subject 10 (Figure 5.3), who had the lowest frequency of all subjects of On-task Independent in the Alone condition, and the most of all subjects in the Partner condition.

Figure 5.5: Children Off-task Independent Frequency



child

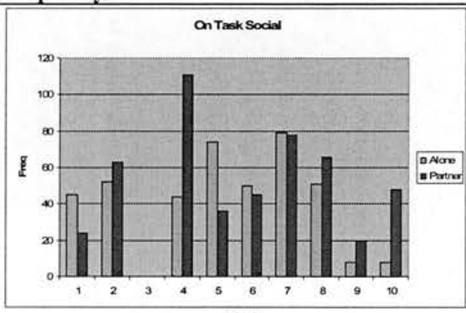
Figure 5.6: Children Off-task Independent Duration



child

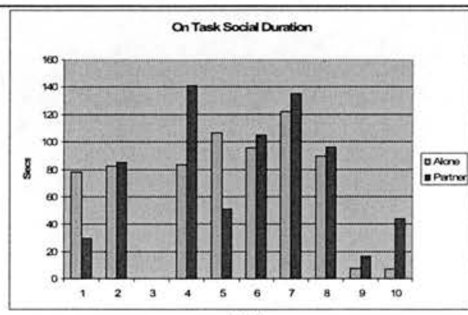
As for the Off-task Independent behaviour, both the frequency (Figure 5.5) and the duration (Figure 5.6) showed clearly that subjects 6 and 9 were much more Off-task during the Partner condition.

Figure 5.7: Children On-task Social Frequency



child

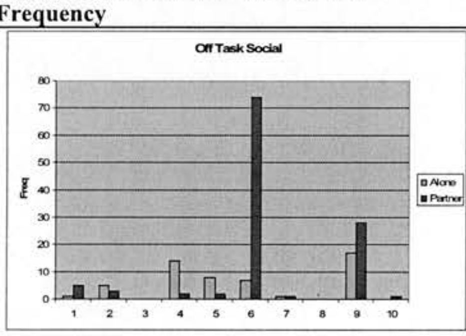
Figure 5.8: Children On-task Social Duration



child

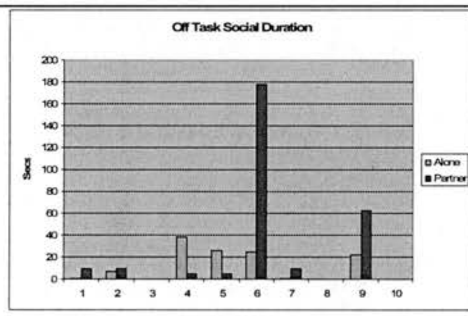
Figures 5.7 and 5.8 show a similar pattern where subjects 1 and 5 displayed more On-task Social behaviours while in the Alone conditions and subjects 4 and 10 did so in the Partner condition.

Figure 5.9: Children Off-task Social Frequency



child

Figure 5.10: Children Off-task Social Duration



child

Similarly, Figures 5.9 and 5.10 show that subjects 4 and 5 were a more Off-task Social when in the Alone condition, although this was not a highly frequent behaviour. On the other hand, subject 9 display this behaviour in both conditions, with more occurrences in the Partner condition. However, the most striking case was subject 6 who clearly displayed the behaviour in the Partner condition.

Looking at Total Social Spontaneous behaviour, Figures 5.11 and 5.12 (see over) show that subject 6 displayed it more in the Partner condition, and subject 5 did so in the Alone condition (both in frequency and duration). Subjects 4 and 10 displayed more frequencies of the behaviour in the Partner condition.

Figure 5.11: Children Social Spontaneous Total Frequency

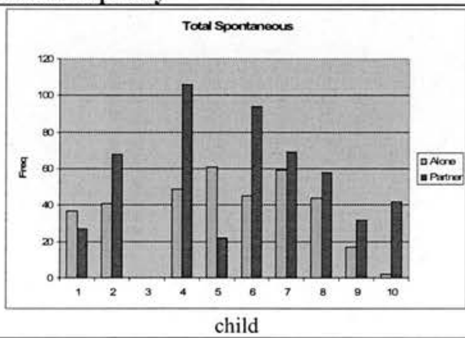


Figure 5.12: Children Social Spontaneous Total Duration

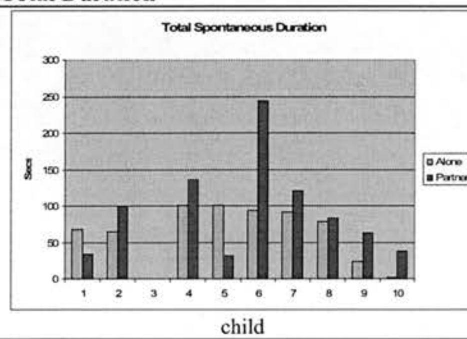


Figure 5.13: Children Social Response Total Frequency

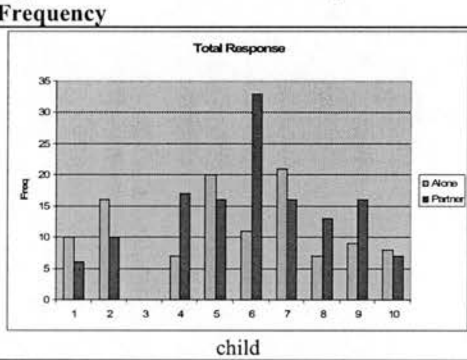
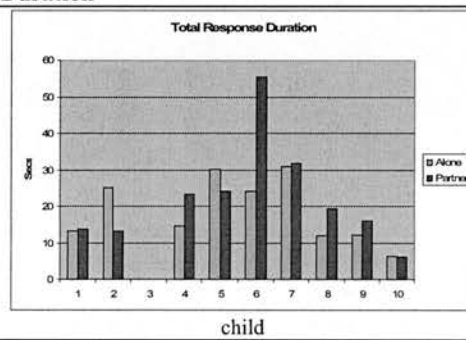


Figure 5.14: Children Social Response Total Duration



A similar pattern follows in the Total Social Response behaviour, with subject 6 clearly displaying the highest amount of this behaviour in the Partner condition, as seen in Figures 5.13 and 5.14.

Figure 5.15: Children On-task Social Spontaneous Frequency

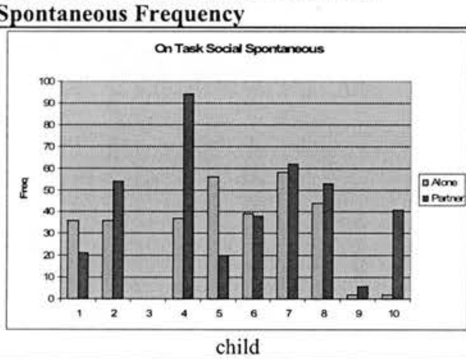
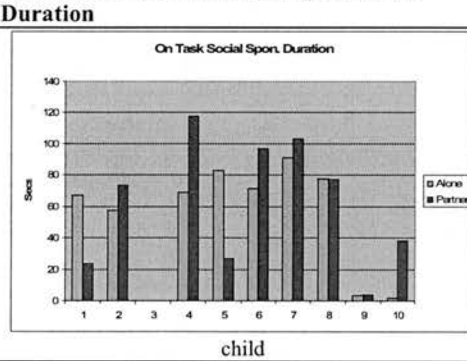
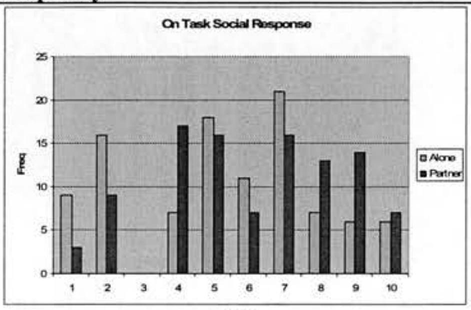
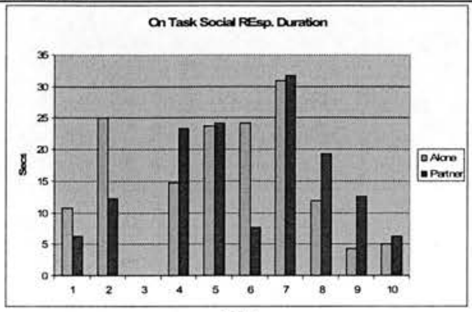


Figure 5.16: On-task Social Spontaneous Duration



Again, values in frequency and duration showed a similar pattern in On-task Social Spontaneous behaviour (Figures 5.15 and 5.16). They indicate that subjects 4 and 10 displayed more of this behaviour in the Partner condition, whereas subject 5 did so in the Alone condition.

Figure 5.17: Children On-task Social Response Frequency	Figure 5.18: Children On-task Social Response Duration
	
child	child

Interestingly, some children appeared more responsive while in the alone condition. As shown in Figure 5.17 and 5.18, subjects 1, 2 and 6 displayed more On-task Social Response behaviour in the Alone condition whereas subject 4, 8 and 9 did so in the Partner condition.

5.4 Discussion

When looking at the group results of the On-task behaviours, in the Alone condition behaviour was less frequent but lasted longer, and in the Partner condition it was more frequent but shorter. This could be explained by the existence of turn taking in the Partner condition, which would have 'interrupted' the On-task Behaviour as well as providing opportunities for distraction, however, it is not possible to draw any conclusions with the available data.

With the child controlling the computer all the time, when playing alone, there was no need for the adult's intervention, e.g. verbally reminding of turns, or physically by handing the mouse back, nor waiting times between matches, so the child remained engaged with the task at hand. The higher number of Off-task behaviours in the Partner condition seems to confirm this engaging quality of the game alone.

Results also showed more On-task Social behaviours in the Partner condition. This was to be expected since the shared game provided opportunities for social interaction (e.g. commenting on a particular move). However, there were still feedback comments from the experimenter and there were opportunities for Social behaviours in both conditions, and these did occur, as shown in the data (see Table 5.3 and Figures 5.7 and 5.8).

As for individual differences, results were consistent with the situation reflected in Chapter 4: some individuals seemed to 'do better' in a particular setting (e.g.: paper vs. computer), with that 'appropriate' setting being defined differently for every individual. The implications of the findings are that the setting can be manipulated to achieve certain goals. For example, if the goal is to have a child spend more time On-task, then letting the child work or play individually with the computer seems the best approach, provided there is a partner with whom to maintain interaction. On the other hand, if the goal is to promote social interaction, then sharing the activity with a partner seems the best course of action in general, although some individuals may need a less intrusive approach than others.

Summary

Overall, the following patterns were evident at group level:

- In terms of duration there was significantly more On-task Independent behaviour in the Alone condition.
- In terms of duration there was more On-task Social behaviour in the Partner condition.
- There was more Off-task behaviour, in the Partner condition.
- There was more Off-task Social behaviour, in the Partner condition.
- There were similar amounts of Social Response behaviours in Partner vs Alone conditions.
- On-task social Verbal behaviours were three times more frequent than Physical On-task social Verbal behaviours.

At an individual level, the data showed:

- Most children were more time On-task in the Alone condition.
- Some children were a lot more Off-task Independent in the Partner condition.
- Some children displayed more On-task Social behaviours in the Alone condition.
- Some children displayed more On-task Social behaviours in the Partner condition.
- Some children displayed a lot more Off-task Social behaviour in the Partner condition.

5.5 Conclusions

Patterns of behaviour showed that children were more time On-task Independent while playing alone against the computer. At the same time, there were more On and Off-task social behaviours when playing with a partner. More importantly, there were clear differences amongst individuals which would need to be taken into consideration when planning a computer-based game activity with an aim to developing social interaction.

Chapter 6: Design issues

Following the comparison study between computer and paper versions of a board game, the nature of the game itself was the next feature to be studied, with a focus on the younger group of children, 6-11 years olds. The competitive nature of the board game may have played a role in the interactions taking place, in terms of the anxiety derived from the uncertainty of the outcome (with the possibility of losing), on one hand, and the added motivation of proving to be better than the opponent (by winning), on the other~~,~~ and, therefore, a game that could be played in a competitive as well as collaborative way was next investigated.

Commercial options were first explored, the rationale being that these would be real games that typical children were playing around the country. Through public reviewed listings found on the internet an initial listing of 1500 games was cut down to around 30 based on type of game, time required to play one session, age appropriateness and availability of multiplayer options.

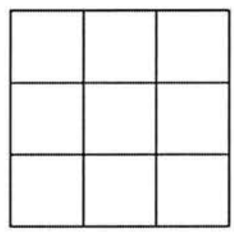
Different types of games reviewed included action, adventure, arcade, board, educational, puzzle, simulation, and sport games. Adventure and simulation games lend themselves to collaboration easily; most of the games reviewed were very sophisticated, requiring a long time to learn as well as to play, and with some taking up to 100 hours to finish. Educational games were not considered because the focus here is on play per se not on academic learning, an additional feature outwith the scope of this research. Many action as well as sports games were predominantly competitive in nature and therefore could not be easily transformed into collaborative experiences; additionally many were not age appropriate. This restricted the final choice to arcade, board and puzzle games, from which only a few provided multiplayer options.

When looking at these remaining games in detail, only a few could actually be adapted to meet the needs of the research, i.e. that they could be played in a competitive as well as collaborative manner. Even then, their multimedia features, with action, colours and sound, none of which could be modified, were judged to have an unacceptable, uncontrollable impact on the study. It was therefore decided that the best option was to custom develop a game that would fulfill the requirements of the research.

6.1 Design Issues: Game

In order to study the effects of collaboration versus competition when playing at the computer a 'new' game was devised: A study-specific jigsaw puzzle. Solving puzzles is an activity that lends itself to being performed in both modes as well as being enjoyed by most children. They offer several choices regarding presentation, features and functionality of the game. All of these issues had to be analysed before making decisions about the specific design of the game and the experiment and were also discussed with experts in education, in special needs and in research design.

Figure 6.1 Jigsaw puzzle grid.



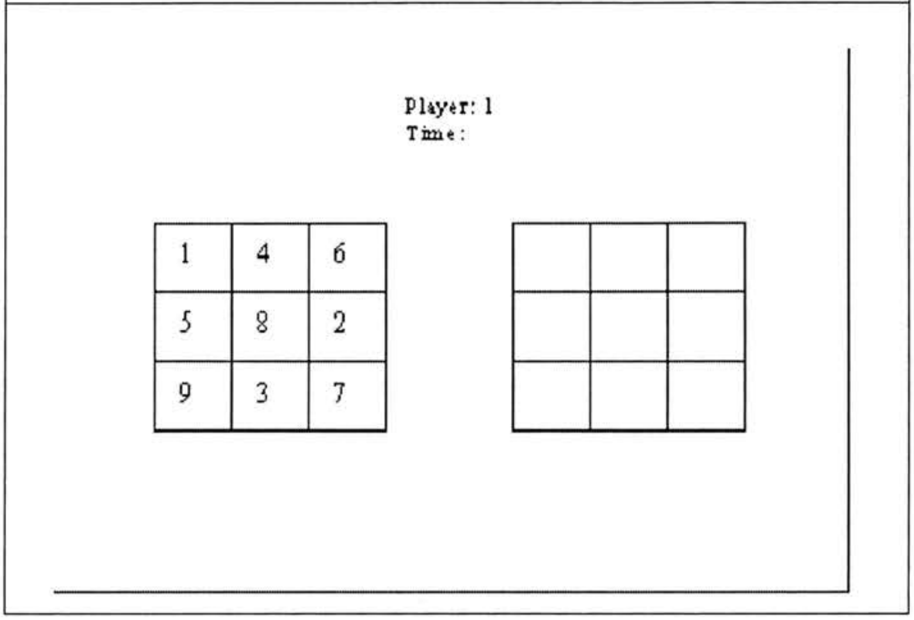
Following the experts' feedback, an initial design was established in which both children and experimenter would solve jigsaw puzzles at the computer, taking turns to put a piece in a 3x3 grid (see Figure 6.1). Figure 6.2 (see over) shows the layout of the pieces, which were designed with straight-sided symmetrical shapes to avoid children using the shape of the pieces to solve the puzzle instead of the visual information of the image.

As the main goal of the thesis was to find ways to develop social skills in children with autism, to increase spontaneous interaction, to develop understanding of social situations, to heighten awareness of others, to promote sharing an interest, and such like, this too was built into the design process at all stages.

6.1.1 First principles

Following the advice of experts and teachers who experienced that different elements on screen may distract children with autism from the task at hand, it was decided that the game would start with a clutter-free computer screen, on which jigsaw pieces were randomly grouped in their presentation box and had to be placed in a destination box. There was also a message box stating whose turn it was and a box displaying the time taken to finish the puzzle, as seen in Figure 6.2 (over).

Figure 6.2: Initial layout design.



Within this setup, several questions arose:

- Should players have separate sets of pieces to place (each player his own) or share from one common set?
- Should pieces be shown randomly arranged from the beginning or is an initial model image needed?
- Should placing options be restricted?
- Should places for positioning pieces be available in the vertical and horizontal plane only or also on diagonals?
- Who should start the game?
- What counts as a turn: when a piece is placed correctly or each attempt at placing, whether correct or incorrect?

Should players have separate sets of pieces to place (each player his own) or share from one common set?

Given the intention of fostering awareness of the other player during collaboration, it seemed that having two separate sets of pieces would make each player independent of the other whereas having one shared set would build in a partner relationship.

Figure 6.3: Initial design with two sets of pieces.

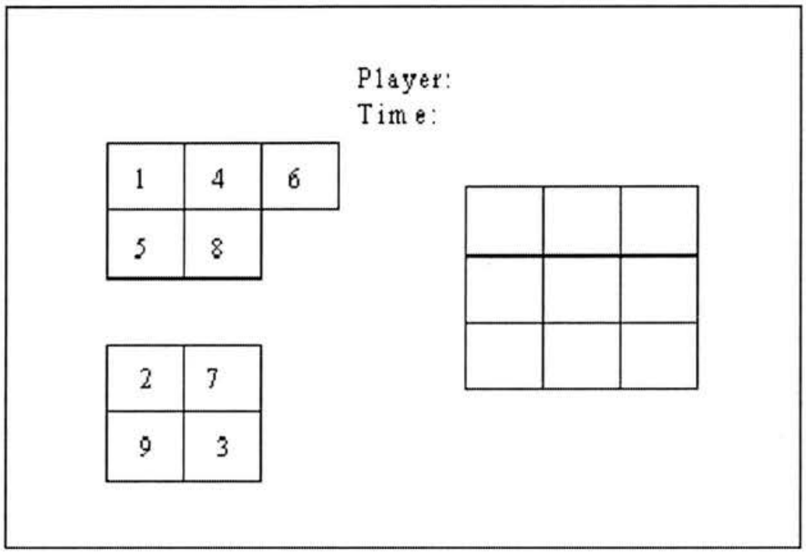
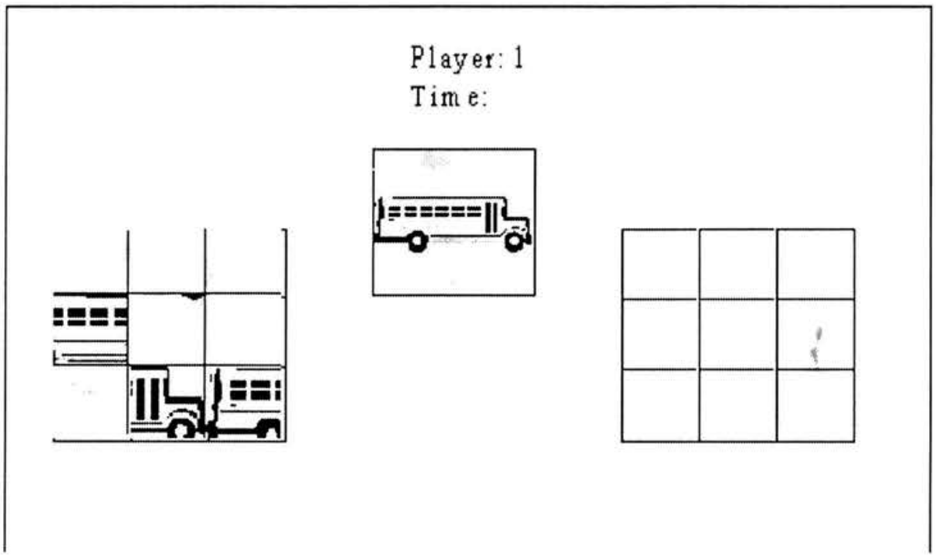


Figure 6.3 shows a competitive situation in which each player handles a different set of information (different pieces), not shared, and each of them has limited information. All a player has to worry about is where to place his own pieces. By contrast, in the one box setup (see Figure 6.2) player 1 is playing with the same set of pieces as player 2; his choices therefore have an immediate and direct effect on the set player 2 has available for his next move. This means that player 1 is influencing the moves of player 2, who is thus a little more aware of player 1 than in the two boxes case as shown in Fig. 6.3.

The same options could be analysed from a collaborative perspective: two sets of pieces are associated to two players, which fosters the idea of competition, one against another, whereas one set, shared between the two people, suggests two people playing as one, in collaboration.

Should pieces be shown randomly arranged from the beginning or is an initial model image needed?

Figure 6.4: Design with model.



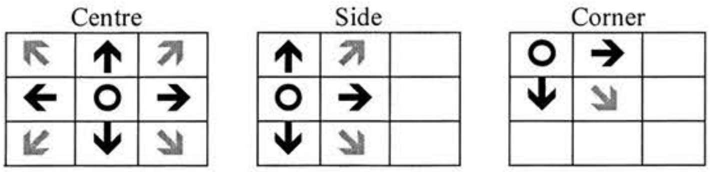
The presence of a model solution of the puzzle, either all of the time, or before the start of the game, influences the difficulty of solving the puzzle (Figure 6.4). A small pilot with three adults using a paper model of a basic jigsaw puzzle showed that they benefited from knowing what the image looked like, although they could easily solve some simple images without a model. Piloting a set of images with the target user population is therefore the only way to find out about the difficulty level of the particular images to be used.

Should placing options be restricted?

When solving jigsaw puzzles, the least sophisticated strategy is to try and place a piece at random, but there are more systematic approaches, given that the first piece placed will facilitate the correct choice of the ones next to it. Failing the recognition of a particular piece/place pair, following a systematic method, the possible strategies would be these:

a) start with the centre piece
b) start with a side piece
c) start with a corner piece

Figure 6.5: Information potential



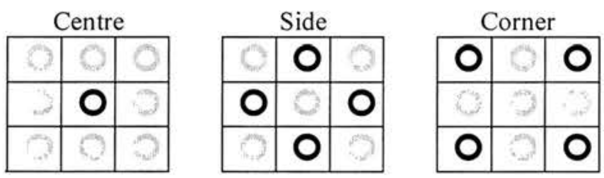
Strategies can be analysed by their information potential, following Shannon's theory of communication (1949), bearing in mind that the puzzles to be used will consist of 3x3 pieces, as seen in Figure 6.5:

a) *Centre*: this piece contains information related to the other 8, although, if not admitting diagonals in the game, it opens only 4 places to other pieces (in the vertical and horizontal plane).

b) *Side*: each of these pieces contains information related to other 5, opening 3 places in the game if diagonals are not included.

c) *Corner*: these pieces contain information related to 3 others, opening 2 places in the game if diagonals are not included.

Figure 6.6: Interaction potential



The strategies can also be analysed by looking at their potential to create situations for interaction, as shown in Figure 6.6. The following analysis is based on trying to place only one piece correctly:

a) *Centre*: there is 1 place, and 9 pieces. In the worst case scenario, the player will have to try all the pieces in one place, making a maximum of 9 attempts.

b) *Side*: there are 4 places, and 9 pieces. In the worst case scenario, 5 of the 9 pieces do not go in a side, and if tried in each of the 4 sides, will make up to 20 attempts after which no piece has been placed. Any of the remaining 4 pieces will go in a side, and in the worst case scenario, will require 4 attempts to find the right place (the next, 3, next 2, and the last one, 1, thus 10), a maximum of 30 attempts.

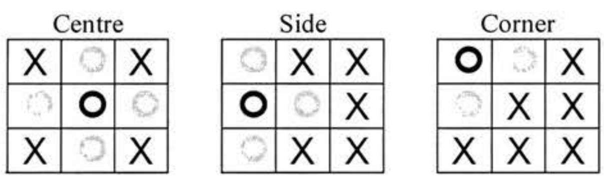
c) *Corner*: there are 4 places, and 9 pieces. In the worst case scenario, 5 pieces do not go in a corner, and if tried in all 4 corners, makes 20 attempts. Any of the remaining 4 pieces go in a corner, and in the worst case scenario, will require 4 attempts to find the right place, a maximum of 30 attempts.

In sum, the more information there is in an option, the better the strategy. Also, a small maximum number of attempts is an indicator of a better strategy. However, the number of attempts required is directly proportional to the opportunities for requesting or providing assistance. These aspects had therefore to be considered when designing the experiment.

Should places for positioning pieces be available in the vertical and horizontal plane only or also on diagonals?

One of the rules could be that the first piece can be placed anywhere. After that, the basics of the game would be to place another piece anywhere, as long as its position is correct in the end. Not allowing diagonals would restrict the options of places available after the first piece has been placed. This would make the game a little more complex by adding one more rule, the restriction of diagonals, which is to say, the player may have found the correct piece for the right place, but it would not yet be possible to place it. It would then not only be a question of picking the right piece/place pair, but of doing so at the right time. Given that the game is already fairly simple, this complexity could make it more interesting. More importantly, any difficulties arising from this additional rule would create an opportunity for interaction.

Figure 6.7: Possibilities without diagonals allowed



In this case, the game grid presents nine places as follows: 1 centre place, 4 side places, 4 corner places (see Figure 6.7). Without diagonals, considering placing the first piece in any of these three options, the possibilities for the next move again differ:

a) The centre piece opens 4 side places, but 4 corner places are blocked (4:4).
b) Each side piece opens 2 corner and 1 centre place, and blocks 2 corner and 3 side places (3:5).
c) A corner piece opens 2 sides, and blocks 1 centre, 3 corner and 2 side places (2:6).

After the first move, 4 and 6 potential mistakes may arise due to placing a piece in the right place but before it is available. If a mistake can be associated with an opportunity to ask for help or explanations, then this builds in at least 4 potential interactions.

Figure 6.8: Possibilities with diagonals allowed

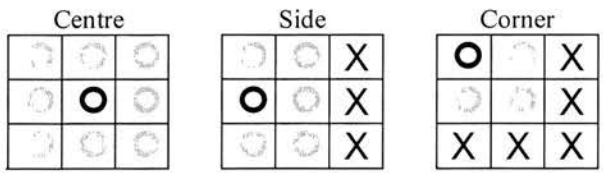


Figure 6.8 shows the possibilities after the first move, when diagonals are allowed:

a) The centre place opens 4 side and 4 corner places, with no restrictions (8:0).

b) A side place opens 2 corner, 2 side and 1 centre place, blocks 2 corner and 1 side place (5:3).

c) A corner place opens 2 sides and centre, blocks 3 corners and 2 sides (3:5).

After the first move, there would be from 0 to 5 potential mistakes from trying to place a piece in a place not yet available. As soon as a piece is placed in the centre, all the remaining places become available, thus the rule of availability does not restrict the game any longer. To prevent this from happening too soon, a rule such as not allowing the first piece to be placed in the centre, could be introduced. This would ensure that 3 to 5 potential mistakes could take place.

This analysis could be taken further, but the above is sufficient to justify that the rule of not allowing diagonals creates more opportunities for interactions in the form of more potential mistakes.

Who should start the game?

In a real game situation, it is frequent that both players take turns to start, but there are exceptions to this rule as well. Here, if the experimenter starts, she can choose the first move, therefore defining the options the child may get next. If the child starts, he can choose his options more freely. To avoid that freedom of choice, the restrictions may be determined by the rules of the game, to ensure a consistent game playing, regardless of who starts.

What counts as a turn- when a piece is placed correctly or each attempt at placing?

A first option could be to count a turn only when a piece is placed in the correct position. This means the player could try with the same piece or a different one until he finds a correct position. The other option could be to count each time a player attempts to place a piece as a turn, which means he could try only once in each turn. This would be assuming that the game rejects incorrect moves, i.e. the piece is in the incorrect place, or the correct place is not yet available (as any move has to be next to another piece, horizontal or vertical, but not diagonal).

If the turn lasts until a player places one piece correctly, then the child might use his own strategy (even trial and error) until he achieves his goal, ignoring the other player. On the other hand, if the child loses his turn when he fails, that may lead to asking what was wrong, or asking for help and thereby more opportunities for interaction. This option therefore has more potential for collaboration.

6.1.2 Other Issues

Levels of interaction: collaboration vs. competition

There are three levels of interaction at which the collaborative and competitive versions may be analysed: physical, cognitive and social. The physical level would involve the lay-out of the experimental set up, the interaction with the computer, direct contact between the partners, and indirect contact by means of a mediating object, e.g. the mouse. At the cognitive level there would be elements such as understanding of the task, including sharing a set of pieces or choosing pieces from an independent set. The social level would indicate to what extent a player has some awareness of the other, and how he relates to that other.

The requirements at both the physical and cognition level may be similar in both the collaborative and competitive conditions. There is the tactile sharing of the mouse, and the visual sharing of pieces in the same box, as well as the verbal interaction required to solve some problems. On the other hand, the interaction at the social level may be very different when working on the puzzle either collaboratively or competitively. When collaborating, both players acknowledge a shared goal: they are 'playing together' to beat the machine. When competing, each player has a different goal: player 1 wants to beat player 2, and player 2 wants to beat player 1.

An additional factor to be considered is that the child can see solving a puzzle as a personal challenge. A timer could therefore add a component of competition against the computer (which sets up the time limit). This would offer another experimental condition: the child against the computer, which could also be perceived as the child against himself (trying to beat his own record). The resultant reinforcement could be positive, making a fuss of the child solving the problem before time ("You win"). Alternatively, reinforcement could be negative, making a fuss of the child not solving the problem before the time limit ("The computer wins, you lose").

Experimental design issues

Four variants of collaborative vs. competitive context solving the jigsaw puzzle were available:

Collaborative: child and experimenter together, collaborating against the computer.

Independent: child alone, against the computer.

Assistive: child against the computer with experimenter as helper.

Competitive: child competing against experimenter.

As the child alone against the computer had been investigated already in Study 2 (see Chapter 5), it was judged unnecessary to explore this further here.

In implementing the *competitive* option, consideration would have to be given to the switching in roles of the experimenter from a potential collaborator to a competitor and vice versa as the child could have difficulty accepting help or collaboration from someone he was competing against just a few minutes earlier. This could be solved by placing this variant at the end of the experimental session. Likewise, more interaction might take place when the *collaborative* option precedes the *assistive*, than when the *assistive* precedes the *collaborative* because collaborating with the experimenter would create an opportunity for social learning that might be carried out to playing alone but with the experimenter available as a helper. A design including options *collaborative*, *assistive* and *competitive*, with the order variation of *assistive*, *collaborative* and *competitive*, therefore seemed appropriate.

The *competitive* option could be designed in different ways:

1. Solving different puzzles of the same level in turns, to see who is fastest (e.g. player 1 would solve puzzles n.1, 3, 5...).
2. Solving the same puzzles, but taking turns to start (second player would have the advantage of having seen the model completed by the first player - player 1 would be the first to solve puzzles n.1, 4, 5...).
3. Solving the same puzzles, as each can within a specified time (player 1 would solve puzzles n.1, 2, 3...).

The first two design options have the advantage of keeping the child more engaged throughout. Furthermore, the second option, by giving the child the advantage sometimes of starting second, might give him further motivation to remain interested in what the other player is doing. However, it also adds more variables, such as learning, into the equation.

When competing against the experimenter, the game is based on solving a whole puzzle independently, therefore what a player does, does not influence what the other one does, since the second player starts from scratch, except in the design option where the second player has seen a model of the solution. This means that the difference between the first and third versions is minimal, since the goal is to be the fastest. The first option, solving different puzzles would provide a more direct feeling of competition because there are many opportunities to be better than the opponent, with feedback on the result after each puzzle. The third option is also competitive, but once the child has done his puzzles, he may just wait uninterested for the results of the experimenter.

All the above issues will be revisited in piloting a prototype of the puzzle game (see below) and when analysing the final outcomes of the experiment (see Chapter 7).

6.2 Formative evaluation

Before using a new game designed specifically for this research, it was necessary to ensure that its layout and functionality were appropriate both for the users and for the purposes of the research. In order to do this, a formative evaluation was carried out.

A formative evaluation, in the area of Human-computer Interaction, takes place during the design process when designers want to make sure their ideas will work, and they do so, among other methods, by observing users' interactions with the machine, gathering their opinions, and running tests (Preece et al., 1994).

These methods tend to be applied to sophisticated computer systems, but the same principles apply here, despite the relative simplicity of the experimental context. It is vital that the final game design fulfils the requirements of the research and to ensure this, the design, prototyping, and evaluation process have to be carried out with the same rigour.

There are two main types of methods: objective, such as those based on measurement of performance, and subjective, such as those based on the user's opinions. The first is used to measure whether the design works as expected, and the second, how satisfied users are. Both measures are important because if the users do not like using a system, it will not be used (Preece et al., 1994). Considering the final game as the 'system' to be used (playing a visual game on a computer), an activity generally pleasing to children, subjective evaluation was deemed unnecessary. However, users' opinions were taken into account for other purposes during the early stages of design.

6.3 Prototyping the game

6.3.1 Aim

- To find out how long it took to solve a range of 3x3 jigsaw puzzles.
- To identify any difficulties in playing the game itself (e.g. with playing rules).
- To identify any problems with the computer game of the implementation (e.g. quality of images).
- To gather opinions from users.
- To observe the collaborative process between players (turn taking, etc.).

6.3.2 Participants

Two child participants were approached with parental consent. The first one, Child A, was a 14 year old typically developing male with dyslexia. The second one, Child B, was a 10 year old male with autism but no additional learning difficulties.

6.3.3 Methods

Task description:

There were three jigsaw puzzles to be solved on a computer, one at a time: a flower, a bus, and a car. The first two images had a limited range of colour whereas the last was in black and white, but all of them were simplified schematic images rather than fully-detached representations. The image filled a square broken down to 3x3 pieces. Initially, the game was presented to the child with the pieces already mixed up and as individual cells (spread over a slightly bigger surface than the original square, but still organised in a 3x3 shape). The pieces had to be placed in a 3x3 frame to the right side of the pieces, in the centre of the screen. The size of the pieces on screen was approximately 1.2x1.2 cm (less than half an inch).

Child A

Child A (child with dyslexia) was tested at home. The session followed this structure:

1. Child and researcher were sat side by side.
2. Greeting followed by introduction of the game and how it was going to be played.
3. Child played with 3 different puzzles, in collaboration and then alone.
4. Child answered researcher's questions about the game.
5. Finish session, thank the child.

Session

1. Image: bus. Mode: collaborative. Time taken: 2 min.
2. Image: flower. Mode: collaborative. Time taken: less than 2 min.
3. Image: flower. Mode: alone. Time taken: less than 1 min.
4. Image: car. Mode: alone. Time taken: less than 1 min.

Observations

1. Difficulty level: the three different puzzles clearly needed to be tested with other users.
2. The child found collaborating "Fine, but a little awkward; ok mentally but it was slow for passing the mouse. A puzzle you normally do it on your own".

Child B

Child B (child with autism) was tested at home. The session followed this structure:

1. Experimenter played with a sibling, sat side by side, to introduce the game.
2. Invited child with autism to play.
3. Played with 3 different images, first alone, then in collaboration and alone again.
4. Child answered researcher's question about the game.
5. Finish session, thank the child.

Session

1. Image: flower. Mode: alone. Time taken: 2 min.
2. Image: car. Mode: alone. Time taken: <2 min.
3. Image: car. Mode: alone. Time taken: <2 min.
4. Image: bus. Mode: alone. Length: 2 min.
5. Image: bus. Mode: alone. Time taken: <2min.
6. Image: car. Mode: collaborative. Time taken: <2min.
7. Image: flower. Mode: collaborative. Time taken: <2min.
8. Image: bus. Mode: collaborative. Time taken: <2min.

Observations

1. The child engaged in playing fairly quickly. The initial plan has been to start with a collaboration game, but the child ignored the experimenter's requests, who therefore allowed him to play alone. He ignored the experimenter's hints at placement most of the time, not taking advantage of them.

2. A pattern developed: Child B would play, leave the room and come back to play again, at his own will.
3. The child's beginning tactic was to transfer the pieces to the equivalent position in the destination frame (i.e. first row, first column cell in "muddled" set to first row, first column cell in game box), ignoring the final image.
4. After being shown visually and told verbally what the image was (a car), Child B applied a different strategy which lead to the solution.
5. Eventually, Child B accepted the introduction of a new rule (collaboration) presented slowly and with minimal language: "A new rule, now we take turns: you put one, I put another".
6. Turn taking occurred smoothly over the following games.
7. When asked which of the three puzzles he preferred, Child B seemed anxious and did not answer but played with the computer on his own, ignoring the experimenter's query.

Summary:

1. All puzzles take 1-2 min to solve.
2. Difficulty levels differed from expected.
3. Pieces 1.2x1.2 cm were not too small for a 10 year old.
4. Some misplacements could not be corrected due to a programming problem.
5. Child B did not keep to turns as regularly in the collaboration games.

Implications for design:

1. Require at least 5 images, probably more, to ensure a minimum of 5 minutes of interaction.
2. Need to test different images to determine their level of difficulty (both in terms of time to solution and user's opinions).
3. Need to increase the overall size of the images to make it more comfortable for younger children.
4. No mistakes should be allowed (allow progressing to a piece only to be positioned in the correct place).
5. Need to enforce turn taking.

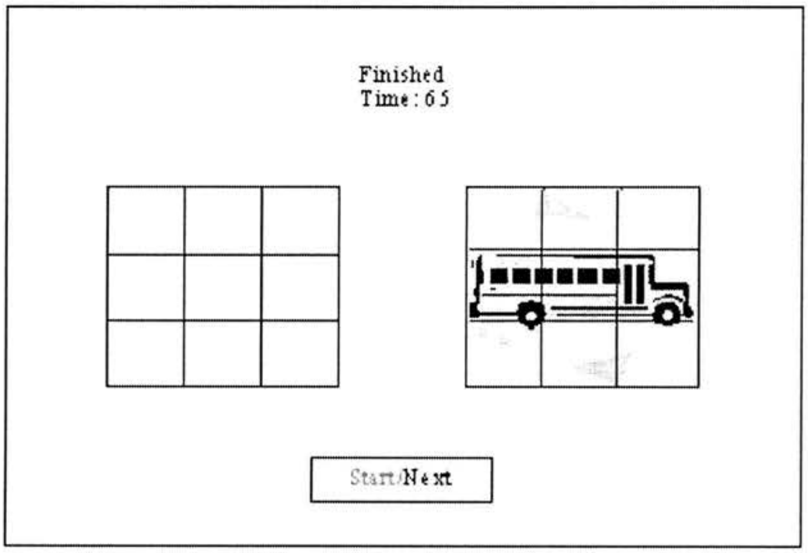
6.4 Modified game design

Following the prototyping test, the game was modified accordingly, with new specifications:

6.4.1 Presentation

Figure 6.9 (below) shows the modified game design. The background was white; two white grids of 3x3 cells, of 2x2cm each, a button that said 'start' at the bottom, a small box on the left top to state the puzzle number and another empty box in the top centre to state the current player or 'finished', when finished. Below this box, the time (in seconds) taken for the solution of each puzzle was displayed. All outlines, fonts and drawings were in black.

Figure 6.9: Modified game design.



6.4.2 Playing

After clicking the start button, the pieces of the first puzzle appeared mixed up in the grid on the left, the button start became a 'next' button, time started running from 0, and the destination grid on the right became green. A player had to press the left button of the mouse over a piece from the left grid to select it, then drag it to a cell in the right grid and release the button to place it. If the movement was correct, then the piece would stay there, if not, it would not release and the player would have to try again. After a piece was placed correctly on the target grid, the cell it was occupying on the left appear in red, to signal it was empty. Due to the shape of the images chosen, some had a corner piece that was predominantly white and it was therefore necessary to make it obvious to the player that a white piece was still part of the final image and had to be placed as well.

6.4.3 Rules

Only pieces in the correct position were accepted and they could not be moved around in the destination grid (right hand side). The first piece could be anyone but in order to place any of the remaining pieces, they had to be placed beside, underneath or above another one. This meant that attempting to place a piece in the correct position could nonetheless fail because there was not yet any other piece on its left, right, top or bottom cell, thus the correct position was not available.

6.5 Images Evaluation

After the layout and features of the game were modified, the set of images to be used in it needed to be redefined through an experimental evaluation.

6.5.1 Aims

- To identify a homogeneous set of images that could be divided into 9 (3x3) squares, each of which would be unambiguous and distinctive.
- To establish criteria to define difficulty levels for each of those images.
- To find out the likely solving times for study users, in order to estimate the number of images needed.

6.5.2 Participants

Three adults (one male and two females, aged between 34-59) and six children (three boys and three girls, aged between 4 and 9) were involved in a sequence of tests, each having different levels of familiarity with computers.

6.5.3 Methods

Four tests were carried out using the same set of images. The images were selected so as to have no intrinsic social content, whilst still being sufficiently interesting to be motivating. Different themes, such as animals and cartoon characters, were considered but finally a transport theme was chosen as best meeting the above requirements. Cars were preferred because of their general appeal for children, boys in particular (boys being the majority of the research subjects).

A set of 43 different images of cars was tested to gather information about the level of difficulty each might present. Their appearance was broadly similar: images were black and white, and used simple lines. The cars were old, modern or unusual; some appeared complete but were presented partially (but always showing at least a full wheel, and a recognisable front and side). Different perspectives were also represented. Images were grouped by similarity, and so presented a degree of order. The first group (12) were old cars that were mostly complete. The following group (18) were more modern cars, but from a variety of angles or with only a smaller part of the car present. The remaining set (13) was a collection of vintage cars and old racing cars.

Test 1

Three adults solved each of the 43 images in the same order. Adult A was a 59 year old female who has used computers rarely. Adult B was a 34 year old female who used computers daily. Adult C was a 34 year old male who used computers daily and was a regular computer game player. The only rule at this stage was that pieces in the wrong cells were rejected by the computer and would re-appear in their initial position in the left box.

Subjects were asked to provide a rating of difficulty for each puzzle (1= very easy, up to 5= very difficult), and the time taken was recorded.

A further analysis of the images provided another potentially relevant criterion: the amount of information in each image. Each was given a number based on the sum of a rating of each of its nine pieces. To simplify this process, the rating evaluated the lines that would continue through the borders, as giving a unit of information. Under this rule, a piece with no lines or with a line that did not touch any border would have a 0 amount of information; if a line carried through one border, it would be given a 1; if there were lines through 2, 3 or 4 borders, then the piece would be marked with a 2, 3 or 4 value.

Table 6.1: Comparison among criteria.							
Image number.	Time (average)		Image number	Difficulty (average)		Image number	Information (total)
32	30.0		3	1.0		39	15.0
14	31.3		4	1.0		41	15.0
6	31.7		6	1.0		32	16.0
25	32.0		7	1.0		3	17.0
26	33.3		13	1.3		30	17.0
22	33.7		25	1.3		40	17.0
40	33.7		8	1.7		4	18.0
35	34.3		12	1.7		22	18.0
3	34.7		14	1.7		25	18.0
27	34.7		16	1.7		1	19.0
31	34.7		26	1.7		14	19.0
11	35.7		1	2.0		36	19.0
39	36.0		5	2.0		31	20.0
42	36.3		10	2.0		37	20.0
7	36.7		11	2.0		38	20.0
10	36.7		15	2.0		19	21.0
20	36.7		17	2.0		20	21.0
4	39.0		27	2.0		24	21.0
16	39.0		28	2.0		33	21.0
28	39.0		39	2.0		34	21.0
43	39.0		2	2.3		35	21.0
17	40.3		18	2.3		42	21.0
13	40.7		20	2.3		6	22.0
12	41.3		22	2.3		10	22.0
18	41.7		32	2.3		16	22.0
37	42.0		33	2.3		21	22.0
33	42.7		35	2.3		2	23.0
34	43.0		37	2.3		12	23.0
38	43.0		38	2.3		13	23.0
8	43.3		9	2.7		23	23.0
21	43.3		21	2.7		26	23.0
5	44.0		23	2.7		27	23.0
23	44.7		31	2.7		43	23.0
41	46.0		40	2.7		8	24.0
19	46.7		41	2.7		9	24.0
9	47.3		42	2.7		17	24.0
36	47.7		19	3.0		18	24.0
30	49.0		34	3.0		29	24.0
15	49.7		43	3.0		5	25.0
29	50.0		24	3.3		15	25.0
24	60.3		29	3.3		7	26.0
1	70.7		30	3.3		11	26.0
2	96.3		36	3.3		28	26.0

Table 6.1 presents a comparison of images in order, from left to right on, the 3 different criteria: time taken, perceived difficulty and amount of information given in the piece. As can be seen from Table 6.1, there was no obvious relationship between any two criteria that suggested that a statistical analysis might be useful. The above, together with the fact that the real users were going to be children, with a different perception of difficulty and different stages of development, suggest that the adults' results should be disregarded as a measure of the inherent difficulty of the images.

However, the process allowed the following to be established:

- An adult user might take around 20 seconds to solve any given puzzle (mean = 19 secs, range: 12 – 31 secs).
- A less computer-literate adult user might take more than 3 mins (200 secs) to solve a puzzle (mean = 74 secs, range: 47- 215 secs).
- The first 2 puzzles are likely to take the longest time to complete, despite having similar difficulty levels and similar amounts of information to the following ones (as can be seen from Table 6.1).

Test 2

A boy and a girl, aged 8 and 9 years, were presented with the first 5 images, and a random (although in the same order) set of nine of the remaining images. Although this could not provide an evaluation of the whole set, it confirmed a number of important details:

- The first image again tended to take longer.
- The fastest solution took less than a minute.
- The slowest solution took more than six minutes.

Test 3

A further test was carried out to look at the impact on difficulty level when two colours were added to the images. A boy (6 years) solved the same images in both black and white and in colour, but the times were very similar. The younger girl (4 years) tried to solve the first two images in black and white, which she achieved albeit with difficulty. As a consequence, the addition of colour was considered unnecessary for the resolution of the puzzles and eliminated from the design.

Test 4

Finally, two further children, a boy (6 years) and a girl (9 years), solved all 43 puzzles, in the same order as the previous adult volunteer, to gain information on difficulty from child users. The images were as easy, intermediate or difficult, in accordance with the following criteria:

- The base rating for each user was the average value of the time taken to complete all puzzles.
- An image would be considered difficult if the time taken by the user was more than 10 seconds above his/her average time (base rating), and easy if it was more than 10 seconds below the average.
- The most extreme ratings with the most agreement between the users were considered first, i.e. those images which were clearly difficult, or clearly easy for both users.
- There were intermediate ratings given to those images when the difference between the base rating was of more than 10 seconds for one user and less than 10 seconds for the other, but always in the same direction (e.g. both took longer than their base ratings).
- Images which were difficult for one user and easy for the other were disregarded.

To select sets balanced in terms of difficulty level for each of the three experimental conditions to be used (assistive, collaborative and competitive, described in section 6.1.2), the rated images were selected in order, the easiest ones first, one for each set, until there were none left, then the images of intermediating level of difficulty and finally then with greatest difficulty. This produced a total of 10 images per set, with 10 disregarded as they fill out of multiples of 3. The remaining 3 images were allocated to the set for the competitive condition, on the basis that this might require more images because of the increasing speed caused by learning and possibly heightened motivation.

6.6 Pilot evaluation

Once the game was ready to be played, an experimental protocol needed to be designed and tested.

6.6.1 Aim

- To compare child-adult interaction while solving jigsaw puzzles with the adult as assistant, collaborator or competitor.
- To refine the protocol as necessary.
- To test the game design in real use.

6.6.2 Participants

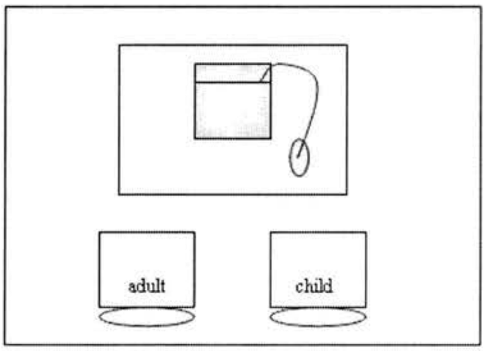
14 typically developing children aged 6-12 years from the same school participated in this part of the pilot. Three children participated in a trial session and another 11 in a full length session. They all attended computing lessons at school.

6.6.3 Methods

The game was first tested for any image and programming errors with one of the children. Once image problems and mouse control bugs were sorted out, two girls completed the full session in order to evaluate the protocol. Table 6.2 (over) shows the protocol tested during the pilot which included the possibility of the child helping out the researcher.

The rest of the children were divided in two groups of matching age ranges, who played sitting side by side with the experimenter as shown in Figure 6.10 (below) with the experimenter's explanations to the child. The order of assisted and collaborative was changed for the 2 groups.

Figure 6.10: Sitting side by side.



The aim was to record five minutes of the child playing in each of the 3 situations: assistive, collaborative and competitive. This required the competitive setting to be twice as long (10 min), since half the time the researcher was going to be playing to match the child's performance. Group A started with the adult in an assisting role, followed by a collaborative session in which both took turns to try to put a piece in the puzzle. Group B started with collaboration, followed by the assistance version. Both groups finished with a competition, with the experimenter and child solving one puzzle each (in turns) to see who was the fastest puzzle solver within the time given for is condition.

Table 6.2 Pilot Protocol

- General:
  o Respond to all child interactions.
  o Look at the child when talking to him/her.
  o Sit side by side, child on the right.
  o Give help when asked.
- In collaborative and competitive conditions:
  o Match child's game (in speed, errors).
- In assisted and collaborative versions:
  o give more unprompted help at the beginning (3 times in first puzzle, then 2, then 1)
  o give more positive feedback (3 times in first puzzle, then 2, then 1)
  o ask the child for help (collaboration only)
- In competitive version:
  o give positive feedback at the end of each puzzle only.
1) Help: indication of the right place for a piece, a hint, e.g. 'look for the side of the wheel', or an explanation of the mistake, e.g. 'that cell is not available yet'.
2) Feedback: 'you are very good at this', 'you are so quick'.

Table 6.3 (below) shows the general structure of the session, and Tables 6.4 to 6.7 (below and over) show each of the stages in more detail:

Table 6.3 Session structure.
1. Introduction
2. Assisted, introduction
3. Play 5 min assisted
4. Collaborative, intro
5. Play 5 min collaborative
6. Competitive, intro
7. Play 10 min competitive

Table 6.4 Introduction.
- We are going to play 3 versions of the same game.
- We will play for about 5 minutes each.
- We have to solve puzzles of cars; some are new, some old, some weird, some you can see fully, some a part only.
- (Shown screen with empty grids) You have to click, hold to drag and release the mouse, from the left box to the correct place in the right box. (shown by pointing on the screen).
- The first piece, you can place anywhere; the following ones have to be close to another piece, on the left, right, above or under (pointing on screen).
- You can ask for help any time you feel stuck.

Table 6.5 Assisted, introduction.
- You are going to solve the puzzles alone.
- I'm here to assist you if you feel stuck.

Table 6.6 Collaborative, introduction.
- We are going to solve the puzzles together.
- We take turns to try to put a piece.
- Whether we put it right or not, we still take turns.
- We can help each other.

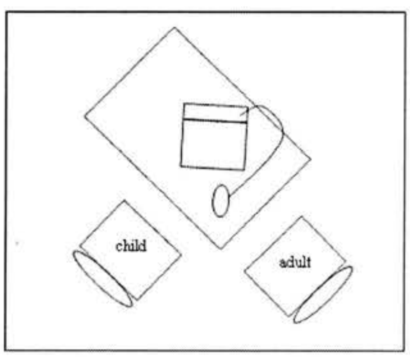
Table 6.7 Competitive, introduction.
- You are going to play against me
- You do the first puzzle, I'll do the next
- We'll see who is fastest

6.6.4 Observations

Difficulty with eye contact

During this pilot with typically developing children, it proved difficult for the experimenter to make eye contact despite that being that a very natural behaviour for the researcher and indeed part of the protocol. This was mainly due to the side-by-side position of child and experimenter, which required a 90° turn of the head (from the screen to the child) to make eye contact.

Figure 6.11: Sitting at 90 degrees.



The motor requirements could be lowered by modifying the setting to a 90 degree seated position (45° angle), thus facilitating the movement of the head (see Figure 6.11). Also, this modified setting would place the child's body to face the empty space between the computer and experimenter, giving these an even opportunity to grab the child's attention. In the 180° setting (side-by-side), by contrast, the body of the child was positioned facing the screen, which made it easy to remain looking at the screen and required a conscious effort to shift attention towards the partner.

It was hoped that this seating adjustment, while not changing the nature of the interaction, facilitated eye contact. This new setting might maximize the opportunities to make eye contact and yet be less confrontational than face to face, with most interactions still mediated by the computer.

Difficulty handling the mouse

It was noted during the earlier studies that most children were right handed and that this required them to make a big move when turn taking in order to place the hand in a comfortable position to use it. This had the purpose, in Study 1, of providing an opportunity to give the mouse back to the experimenter. In this study, there was no such inherent requirement, but the positioning was initially kept for consistency with the previous designs.

Having observed that the positioning with the child on the right made it a little harder and potentially therefore distracting, it was decided to change the mouse position to the left. Although right handed, the experimenter was accustomed to using the mouse with the left hand, and this, together with the change in relative positions made the required movement of the mouse minimal during turn exchanges.

Offering help

In the first sessions it was observed that children were not typically asking for help, and so the script of the collaboration was adapted to include the option of the experimenter asking the child for help. The aim was to model the behaviour so that the child would not to feel embarrassed at asking. This did not have the desired effect. Six of the children (2 of group A) actually then offered help whilst in the competitive version of the game. The researcher accepted this assistance gratefully (e.g. 'thanks') and matched such behaviour, to a lesser extent, as it would have been awkward to have done otherwise.

This behaviour could be interpreted in either of two ways. Although it might indicate transfer from a collaborative mode, it may have been prompted by a desire to participate instead of passively watching the experimenter, while waiting for their turn. At that stage all children had solved a minimum of 3 puzzles, were familiar with the task, and were perhaps bored. Given that the experimenter was matching their performance, it could mean an average idle waiting of 1 minute, opening up the possibility that the behaviour could have been prompted by boredom rather than representing a real gesture of good will.

Not asking for help

Despite the researcher modeling how to ask for help, most of the children did not use the opportunity to do this even when it would have been faster just to ask on many occasions.

Influence of order of presentation on asking for help

When, as in Group B, the children had worked in the collaborative context first, there proved to be little role for the researcher in the assistance mode: they did not need assistance because they already understood the game. However, it was decided not to change the design in this respect as it still served the purpose of allowing investigation of whether providing assistance to the child first would make subsequent collaboration easier or not, an interest of particular relation to the focus of the thesis on children with autism.

6.6.5 Implications for design

In sum then, the implications for design were as follows:

1. Child-researcher positions should be changed from side by side to 90 degree angle (see Figure 6.11, p.149).
2. Child should sit on the left of the researcher.
3. Researcher should not ask children for help.
4. Speed should be emphasized along with the fact that mistakes or help received do not count against the child.
5. Order of presentation of collaboration and assistive conditions should be balanced across study children, but with competition playing kept to last.

6.7 Final version

The final version of the protocol is detailed in Tables 6.8 to 6.13 (see over). The structure of the session showing assisted and collaborative conditions revised with in Table 6.9 for half of the sample.

Table 6.8 General protocol.
– Respond to all child interactions. – Look at the child when talking to him/her. – Sit at 90 degrees, child on the left. – Match child's game (speed, errors). – Give verbal time after each puzzle. – Give encouragement after each puzzle. – Give verbal reminders of turns. – Give help when asked. – Prompt help after 3 errors, e.g. "It's ok to ask for help", "you can ask for help any time". 1) Error: a wrong move, 10 seconds without making a move. 2) Help: indication of the right place for a piece, a hint, e.g. 'look for the side of the wheel', or an explanation of the mistake, e.g. 'that cell is not available yet'. 3) Feedback: 'you are very good at this', 'you are so quick'.

Table 6.9 Session structure.

Group A		Group C
– Introduction. – Assisted, introduction. – Play 5 min assisted. – Collaborative, introduction. – Play 5 min collaborative – Competitive, introduction. – Play 10 min competitive (researcher and child taking turns).		– Introduction. – Collaborative, introduction. – Play 5 min collaborative. – Assisted, introduction. – Play 5 min assist – Competitive, introduction. – Play 10 min competitive (researcher and child taking turns).

Table 6.10 Introduction.
– We are going to play at the computer. – There will be 3 versions of the same game that we will play for 5-10 min. – I will tell you the details when we play. – We have to solve puzzles of cars; some are new, some old, some weird, some you can see fully, some a part only. – (Show screen with empty grids) You have to click, hold to drag and release the mouse, to move a piece from the left box to the correct place in the right box. (show by pointing on the screen). – The first piece, you can place anywhere; the following ones have to be close to another piece, on the left, right, above or under (pointing on screen). – You can ask for help any time you feel stuck. – You have to solve the puzzle as quickly as you can. – Mistakes don't count. – Help doesn't count. – Only time counts.

Table 6.11 Assisted, introduction.

– You are going to solve the puzzles alone.
– I'm here to assist you.
– Remember you can ask for help any time.
  o Mistakes don't count.
  o Help doesn't count.
  o Only time counts.

Table 6.12 Collaborative, introduction.

– We are going to solve the puzzles together.
– We take turns to try to put a piece.
– Whether we put it right or not, we take turns.
– We can help each other.
– Remember you can ask for help any time.
  o Mistakes don't count.
  o Help doesn't count.
  o Only time counts.

Table 6.13 Competitive, introduction.

– You are going to play against me.
– You do the first puzzle, I'll do the next.
– We'll see who is fastest.
– Remember you can ask for help any time.
  o Mistakes don't count.
  o Help doesn't count.
  o Only time counts.
Note: if child offers researcher help in this context: "thanks, but I have to do it on my own".

Chapter 7: Social interaction in collaborative vs. assisted playing

In this chapter, a jigsaw puzzle game was used to observe and compare social interaction when playing alone with the assistance of an adult and when playing together with the adult as a team, with adult and child collaborating on the same puzzle. The study addressed the question of whether the nature of assistive role of the adult may have an influence on the interaction in the collaborative situation. Subsequently, this collaborative condition was compared to a competitive condition in which adult and child played against each other. Eleven children with ASD, aged 7 to 11 years played with a jigsaw puzzle game on a computer under these assistive, collaborative and competitive conditions, consecutively and for 5 minutes at a time.

7.1 Research questions

The study presented here intended to observe social interaction under different computer game conditions. The intention was:

i) To explore whether being first assisted by the experimenter (the Assisted version of the game) had any influence in the interaction while the child was collaborating with her (Collaborative version).

ii) To compare interactions in collaborative versus competitive contexts.

Under these conditions, the following questions arise:

iii) Does the performance in solving puzzles influence interaction?

iv) Do the children's social skills influence interaction?

Any differences in interaction might be manifested in different ways, leading to a number of sub-questions. Under which of these three contrasting conditions:

- Do children engage more in the game?
- Do children remain focused on task longer?
- Do children initiate more interactions?
- Do children respond more to experimenter?
- Do children seek more eye contact?
- What do children do when they are waiting they turn?

7.2 Methodology

7.2.1 Overview

The study involved one session of 25 minutes in which children played with a jigsaw puzzle game under three different conditions. Participants were divided into two matched groups, each starting with either the Assisted or Collaborative version first, continuing with either Collaborative or Assisted, and then both finishing with the Competitive version. The whole session was video recorded in order to obtain 5 minutes of footage of each condition. The Competitive condition involved the child watching the experimenter playing during her turn, therefore it was recorded for a longer time to ensure that there were 5 minutes of the child playing during his turn. Sessions followed a predefined protocol including a script of the researcher's behaviour and playing strategies.

7.2.2 Considerations

Intervention Protocol

The intervention protocol was designed through a careful process, as described in Chapter 6, in order to provide all participants with the same opportunities to interact and enjoy the activity while maintaining a natural flow within individual sections.

Game

Most children of the age range of the children participating in this experiment are familiar with jigsaw puzzles. There are several accounts reporting that children with ASD are even more interested in this type of game, making them a motivating choice for this research population. The game used was also designed and evaluated to ensure that its features met the needs of the study. Rules were programmed in order to make the solution less obvious and to create the need for assistance (as described in Chapter 6).

Sessions

Sessions were arranged with the teachers to fit within the school day activities of the child. They were organized to take place in the same room for each child with both participant and researcher sitting in a 90 degree position in front of a desk, on top of which there was a laptop set up with the first game on the screen. Initially, the lid was down to avoid distraction during the introduction. The mouse was positioned in the center, between the child and the experimenter, used with the right hand by the child, sitting on the left, and used with the left hand by the experimenter, sitting on the right.

Behaviour pattern

The researcher had to follow two different types of behaviours in terms of playing style when collaborating or competing, and in all conditions had to maintain a consistent interaction pattern.

- **Playing strategy:** This aimed to maximize the motivation of the child by letting him win the match (overall) and many of the games within the match, but without him noticing it. This was achieved by matching the child's ability, by the researcher making mistakes and, more clearly, by taking a similar amount of time in making a decision (in Collaboration) or solving a full puzzle (in Competition).
- **Interaction pattern:** This was designed to keep the participant motivated by providing feedback, praise, encouragement and assistance. It emphasized the creation of opportunities for eye contact by ensuring that the experimenter looked at the child every time she spoke (see section 7.2.4, over).

Protocol fidelity

A written script was used during the sessions to ensure that all children had the same opportunities to understand the instructions for the game and how it was to be played, specifying amount of researcher speech, and degree of adult interaction. It also served as a reminder of the behaviour to be displayed. However, although the video analysis would allow monitoring of how closely the experimenter followed the script in terms of help given, there were aspects that were not recorded simultaneously which may have affected her behaviour, e.g.: what was happening on the computer screen. The social skills and personality of the child might have played a role as well, with the more interactive child prompting a more lively interaction from the experimenter.

7.2.3 Study Participants

The participants were 11 children between 7-11 years old, with a diagnosis of ASD, judged by teachers to have difficulties in communication and social interaction but who were able to become involved in an activity that is not necessarily their preferred one. The children were either familiar with computers or had the ability necessary to use them at a very basic level. They were also familiar with the experimenter because they had participated in the studies reported in Chapters 4 and 5 approximately 3 months earlier.

A detailed description of the participants can be found in Chapter 4 (Section 4.3.5, p. 101). One of the children, C5, had moved to another school and could not participate in this follow-on study. Teachers completed the social items of a Vineland questionnaire again, in order to update measurements of the children's levels of social competence and interaction (see Table 7.1, over). There were some differences in the social age estimated when compared to the earlier measures. In some cases, children were more able, whereas in other cases, Vineland scores were lower than 18 months before (see Table 4.4.). This could have been due to the fact that the children had been evaluated by a different teacher from the previous time, and that the questionnaire, as used, was intended to provide only an approximate measure of social skill level. The action taken to accommodate both the loss of one participant and the updated social skills levels was to reorganise the groups to find the best matches possible, when dividing children into two experimental groups (see Table 7.2, below).

Table 7.1 Participants' profiles.
(Chronological, and social age given in years:months)

Child	Diagnosis	Age	Social	IQ		Group
C1	Asperger S.	10:7	1:6	67		Collaborative
C2	Asperger S.	11:5	1:8	69		Collaborative
C3	Asperger S.	8:10	3:2	72		Assistive
C4	Asperger S.	8:5	3:4	66		Collaborative
C5	Asperger S.			64		-
C6	Asperger S.	8:8	3:0	66		Collaborative
C7	Asperger S.	8:5	3:9	66		Assistive
C8	Asperger S.	9:11	3:1	59		Collaborative
C9	Autism	10:6	1:9	49		Assistive
C10	Autism	10:4	2:4	53		Collaborative
C11	Autism	9:3	3:7	65		Assistive
A12	Asperger S.	9:4	2:8	52		Assistive

Figure 7.1 Children's profiles.

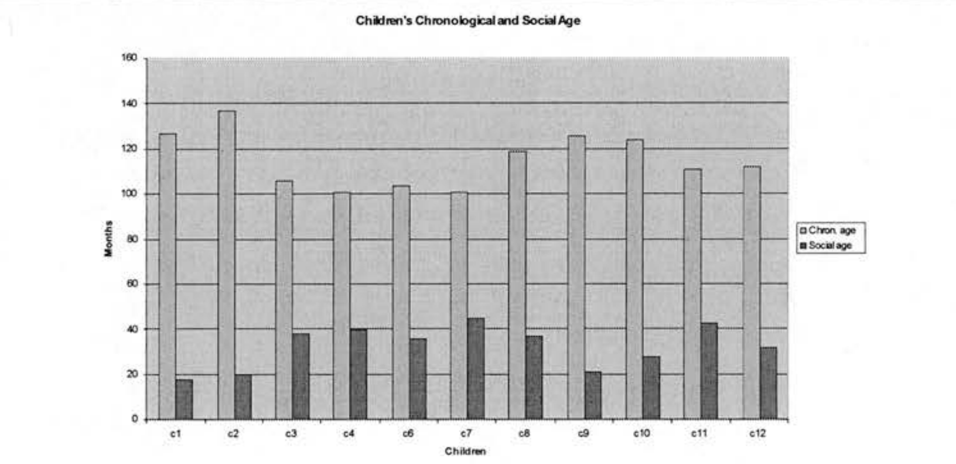


Table 7.2: Group matching

Group	Age	Social	IQ
Assistive first	9:3 (8:5-10:6)	3:0 (1:9-3:9)	61 (49-72)
Collaborative first	9:11 (8:5-11:5)	2:6 (1:6-3:4)	63 (53- 69)
Total Average	9:7 (8:5-11:5)	2:9 (1:6-3:9)	62 (49-72)

Although mean values for age and social skills level differed slightly in the two groups, ranges were broadly equivalent and thus deemed satisfactory for the purposes of the study.

Access

The school all participants attended was approached through an information letter addressed to the head teacher, explaining the nature of the study and its aims. Permission was granted by the relevant authorities and parental consent requested, as in previous studies, by means of a letter which included a brief description of the study described in this chapter. (see Appendices D and E).

7.2.4 Procedure

All the sessions were carried out at the children's school always accommodating to children's schedules to minimize disruption. There was a one-off session in which the three different versions of the jigsaw puzzle game were played at the computer for 5 minutes each. The whole session was video recorded, and as previously indicated, the Competitive condition, which involved the child watching the experimenter playing during her turn, was extended to ensure that there were 5 minutes of footage of the child playing during his own turn. A protocol including a script of the researcher's behaviour and playing strategies was designed to maximize opportunities for interaction and engagement of the child during the session (see Table 7.3 and 7.4, below). The session script has already been described in detail in Chapter 6 (see Tables 6.8 to 6.13, p.152).

Table 7.3 General protocol.
– Respond to all child interactions.
– Look at the child when talking to him/her.
– Sit at 90 degrees, child on the left.
– Match child's game (speed, errors).
– Let the child win, overall, and some games throughout.
– Give verbal time after each puzzle.
– Give encouragement after each puzzle.
– Give verbal reminders of turns.
– Give help when asked.
– Prompt help after 3 errors, (e.g. "It's ok to ask for help", "You can ask for help any time").
1) Error: a wrong move, 10 seconds without making a move.
2) Help: indication of the correct place for a piece, a hint (e.g. 'look for the side of the wheel'), or an explanation of the mistake (e.g. 'that cell is not available yet').
3) Feedback: 'you're very good at this', 'you're so quick'.

Table 7.4 Session structure.		
Group A		Group C
- Introduction. - Assisted, introduction. - Play 5 min assisted. - Collaborative(introduction) - Play 5 min collaborative - Competitive, introduction. - Play 10 min competitive (researcher and child taking turns).		- Introduction. - Collaborative, introduction. - Play 5 min collaborative. - Assisted, introduction. - Play 5 min assist - Competitive, introduction. - Play 10 min competitive (researcher and child taking turns).

7.2.5 Video Analysis

All the sessions were recorded using a digital video camera set 2 meters away from the players, at an angle 45 degrees closer to the child but also capturing the adult, and a third of the laptop. No participants seemed uneasy in the presence of the camera nor did it allow to distract any of the children from the games. The footage of the 11 sessions was divided into 5 minute segments from each condition, providing 33 video recordings for analysis.

The software used was Noldus Observer Video-Pro 5, a video analysis package used in previous studies (see Chapter 4). The 33 recordings were reviewed using a continuous sampling analysis in order to capture all of the behaviours taking place and were analyzed in a random order to avoid any coding bias.

The coding system designed was based on the coding described by Willis et al. (in prep.), and was an adapted version of that used in the analysis of previous studies (see Chapter 4 and 5). This coding focuses on three main categories of behaviours: Verbal communication, Non-verbal communication and On/Off-task behaviour. Child and adult behaviours were coded with a specific interest in the following:

- *Child's behaviour*: spontaneous eye contact, spontaneous speech, initiation of interaction, requests for help, feedback, offers of help, and response to interaction.
- *Adult's behaviour*: initiation of interaction (feedback, praise, encouragement), eye contact, and fidelity to script.

An initial analysis of the video recordings showed the need for a more detailed breakdown of verbal communication behaviours. In one case where the adult's behaviour was very different from the rest of the recordings, it was only by referring back to the recording and observing the interaction in detail that it was possible to identify the specific behaviour which had caused the problem.

After identifying the critical behaviours, a new coding system was developed to suit the nature of the data and the research goals. For example, within the On-task Speech category there was a relatively small number of modifiers or sub-behaviours: feedback, general, and help, among others. The new list of behaviours was expanded and 'feedback' became 'encouragement', 'turns' and 'results' (voicing these to partner), 'help', 'offer prompt', 'direct offer', 'help hint' and 'help solution'. In all more than 80 categories of behaviours were potentially codeable for analysis. (The way categories were specified is to some extend limited by the software restriction. These constrain any behaviour to a maximum of two modifiers, although each of these can have unlimited sub-categories -see Appendix H-)

Behavioural coding

All child and adult behaviours produced under the 3 conditions, Assistive, Collaborative and Competitive were subjected to video analysis. Behaviours were analysed under two main headings : verbal communication and non verbal communication, with these then related to whether bahaviour was On or Off-task (see Appendix H).

Verbal communication

The majority of participants were not very communicative verbally although there was sufficient conversation to support an analysis of this aspect of their behaviour. When an utterance was not clear or incomplete, it was coded as inaudible/incomplete. Utterances could be task related (coded On-task speech) or non-task related (coded Off-task speech), and the modifier 'initiation' defined whether they were spontaneous or in response to the partner.

- On-task speech.
- Off-task speech.
- Inaudible/incomplete.
- Quiet.

On-task speech and Off-task speech made use of the modifier 'Initiate' which defined the following behaviour:

- *Spontaneous*: the subject initiated the behaviour.
- *Response*: the subject's behaviour was prompted by the partner.

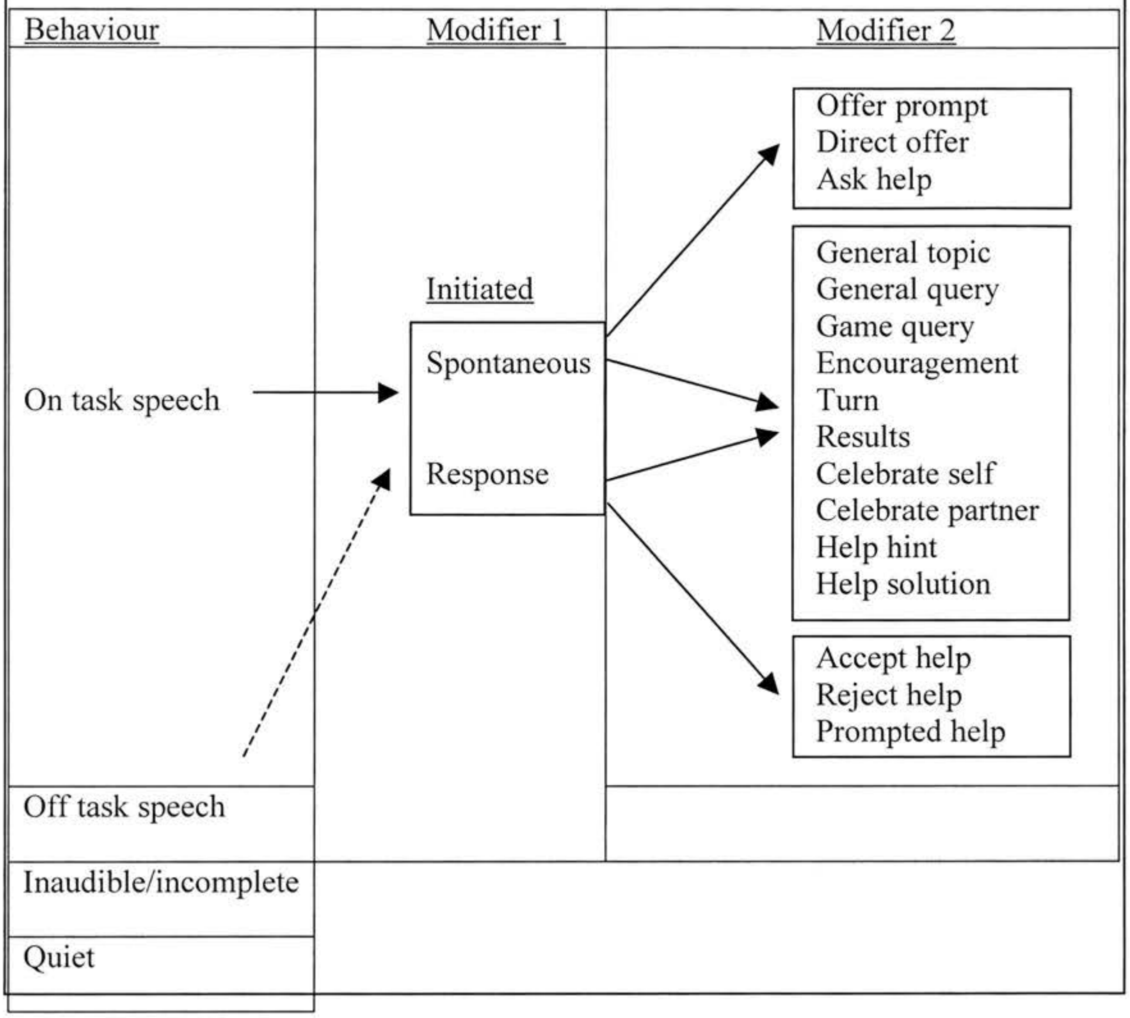
On-task utterances were analysed in more detail by using a second modifier 'on speech', with the following behaviours:

- *Offer prompt*: reminded partner they can ask for help. (e.g.: "Remember you can ask for help any time", "I'm here to help you").

- *Direct offer*: asked directly to partner if he/she needed help. (e.g: "Do you need help?", "Do you want any help?", "Do you want a hint?", "Do you want me to remind you of the rules?").
- *Ask help*: subject asked for help spontaneously. (e.g.: "Help", "I need help").
- *General topic*: topic of conversation was on-task but of a general nature, rather than a query. (e.g. "It's a modern car", "I cannot see the screen", "This is very easy").
- *General query*: task related query of general nature, not critical to make a move. (E.g. "Are we finished yet?", "What was the result?", "Is this the same car as before?", "Have you done this one already?", "Is it my turn?").
- *Game query*: game specific query, answer required for play, could be about the rules or a specific move (e.g. "Why does it reject my piece?", "Is that place available yet?", "Does this piece go here?", "If I do this would it be ok?").
- *Encouragement*: positive feedback regarding performance. (E.g. "Excellent", "That was fast", "You are very good at this", "Nice move").
- *Turn:* reminder of whose turn it is. (E.g. "Your turn", "It's my turn now").
- *Results*: voicing the time taken to solve jigsaw, who wins, etc. (E.g.: "34 seconds", "You are still winning").
- *Celebrate self*: verbal utterances celebrating outcome of game. (E.g.: whoops, giggles, laughter).
- *Celebrate partner*: verbal utterances celebrating partner's results. (E.g.: whoops, giggles, laughter).
- *Help hint*: given a hint that helped to understand the problem, reminded of rules. (E.g.: "That place is not available yet", "The wheels are at the bottom of the image", "It has to be close to another horizontal or vertical", "It doesn't go there").
- *Help solution*: indicated to partner where to put a piece of the jigsaw. (E.g. "Put this piece (pointing) there (pointing)").
- *Accept help*: when asked if he wanted help. (E.g.: partner said "Yes", or "Help").
- *Reject help*: rejects help when offered. (E.g. "No", "Thank you, but I want to do it on my own").
- *Prompted help*: when reminded he can ask for help (*'offer prompt'*). (E.g. "Help", "I need help").

Figure 7.2 (over) provides a schematic diagram of the categories and modifiers used in analysis under this heading.

Figure 7.2 Schematic coding for Verbal Behaviour



Non verbal communication

The behaviour entered in the software by default was No Non-verbal Communication. Non-verbal communication behaviours could be task related (coded as On-task nvc) or non task related (Off-task ncv), with the modifier 'initiation' need to define whether there were spontaneous or a response to the partner's behaviour.

- On-task nvc.
- Off-task nvc.
- No nvc.

On-task non verbal behaviour was analysed further with the modifier 'On nvc':

- *Look*: subject looked at partner.

- *Point*: subject pointed at screen.
- *Celebrate*: gesture of celebration.
- *Attention*: subject touched, grabbed or made gestures to attract partner's attention.

Smiling was considered for analysis but there was difficulty in assessing whether a smile had a social intention or was a nervous reaction. Having gathered from teachers' reports that all children had enjoyed the experience, it was decided not to include it in this final coding system, despite considered its use in an initial analysis.

Off-task non verbal behaviour was also analysed further using the modifier 'Off nvc':

- *Away*: subject looked away from screen.
- *Off seat*: subject was away from seat (if still looking at the screen, was coded as On-task).
- *Off camera*: subject was off camera.

A second observer blind to the purpose of the study scored 10 % of the 33 group's videotapes, after being briefed on the coding method used and given a few practice video clips. There was an 84 % agreement in the frequency of the Verbal behaviour, well above the 70% considered adequate, and the 89% frequency agreement in Non Verbal behaviour contributed to have a total of 86%, indicating that the coding by the first observer was reliable (see Table 7.5).

Table 7.5 Inter-observer reliability (ASD).

	% agreement frequency	kappa	% agreement duration	kappa
Verbal behaviour	84	.78	93	.89
Non verbal behaviour	89	.84	93	.88
Total	86	.81	93	.89

7.3 Results

A first analysis based on the frequency of certain events was focused on the amount of On task/Off task behaviour, on opportunities for eye contact, and on opportunities to interact based on the amount of assistance from the adult partner.

7.3.1 On/off-task behaviour

On-task behaviour, as in the earlier studies, included feedback, praise, assistance and general on-task related topics. Statistical analysis did not show any significant difference among the experimental conditions, except in Adult Offers of Help, but the data will be discussed from a descriptive point of view.

Adult

On-task Spontaneous verbal

In general terms, the adult behaviour was consistent over the different conditions, with similar levels of On-task spontaneous behaviour across individual children within his session. The only exception was with the group that started with the Assistive condition (group A): the adult seemed to produce slightly more On-task Spontaneous Speech (a mean of 20 vs. 13) during collaboration (see Table 7.6).

Table 7.6 Adult On-task Spontaneous total.

group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
Assist.	13	12	16	10	23	15	12	9	10	16	18	14.0	14.8	13.3
Collab	13	38	16	15	20	14	9	10	13	20	14	16.5	20.4	13.3
Compe.	15	14	18	19	18	13	10	14	14	12	19	15.1	16.8	13.7

This difference in means seems to stem predominantly from the researcher's responses to Child C7, with whom the adult displayed a lot more (38) On-task Spontaneous speech in the collaborative condition. A more thorough analysis of the video showed that this was caused by an unusually large number of turn taking requests (29), with the next highest value been only 13 (and 23 in the total On-task speech).

On-task Response verbal

As Table 7.7 (below) shows, the adult's On-task Response was less consistent, with more variations across conditions and children. For example, child C11 was responded to several times (12) when in collaboration and very little in competition (2). There was a strong correlation (r=.624, p=.000) between Adult On-task Response and Child On-task Spontaneous, which showed that the adult's behaviour was closely tied to the child's initiations (see Table 7.10, see p.165). In the case of child C11, he initiated On-task speech on 20 occasions when in collaboration, 13 times during the assistive condition and 11 times during competition. Child C12, by contrast, produced a quite different profile of adult responses across conditions.

Table 7.7 Adult On-task Response total.

group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
Assist.	4	2	0	7	6	5	8	7	1	0	2	3.8	3.8	3.8
Collab	1	0	3	12	9	4	5	5	2	3	0	4.0	5.0	3.2
Compe.	2	2	1	2	12	4	6	3	4	7	0	3.9	3.8	4.0

Off-task Spontaneous and Response

Tables 7.8 and 7.9 show how seldom Adult Off-task behaviour occurred, either self- initiated and in response to a child behaviour. However, since the main goal was to promote interaction, some times the adult responded to the Off-task speech of the child (see Table 7.12, p. 167) in order to maintain rapport.

Table 7.8 Adult Off-task Spontaneous total.											
group	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
assist	0	0	0	0	0	0	0	0	0	0	0
collab	0	0	0	0	0	0	0	2	0	1	0
compet	0	0	0	0	0	0	0	0	0	0	0

Table 7.9 Adult Off-task Response total.											
group	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
assist	2	0	0	0	0	0	0	4	0	0	0
collab	0	0	0	0	5	0	0	0	1	1	0
compet	0	0	0	0	0	1	1	1	1	0	0

Child

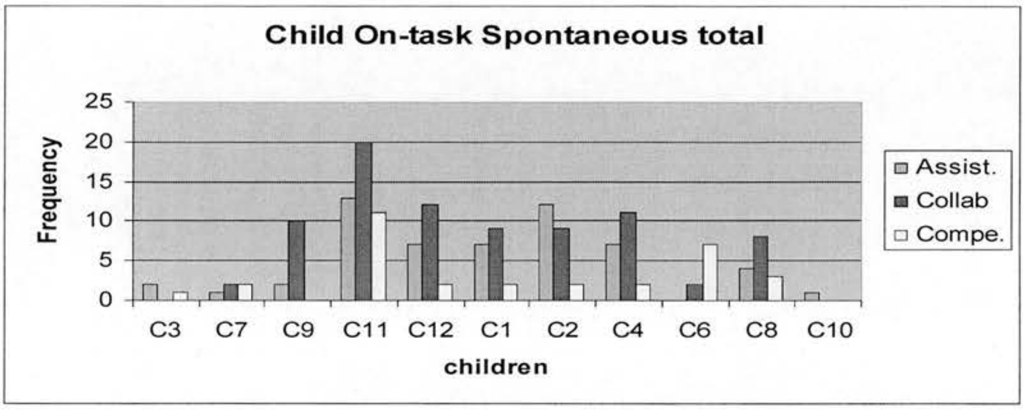
On-task Spontaneous speech

As Table 7.10 indicates, the children seemed to present more On-task Spontaneous speech with collaborative mean: (7.5) than when in the assistive condition mean: (5.1), but more in the assistive condition than when in the competitive condition mean: (2.9), regardless of the condition with which they first started.

Table 7.10 Child On-task Spontaneous total.													
group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
Assist.	2	1	2	13	7	7	12	7	0	4	1	5.1	5.0	5.2
Collab	0	2	10	20	12	9	9	11	2	8	0	7.5	8.8	6.5
Compe.	1	2	0	11	2	2	2	2	7	3	0	2.9	3.2	2.7

This pattern was mirrored in adult On-task Response behaviours in most cases. For example, in the case of C11, the child presented the most On-task Spontaneous behaviour and also elicited the highest level of adult response (see Table 7.5, p.163). On the other hand, child C12 presented what might appear as contradictory values, in particular in the competitive condition, where he showed very little On-task Spontaneous speech, but obtained a high level of response from the adult. This was to a large extent due to the nature of the coding system: in a sequence of events such as the child initiated /adult responded /child responded to the adult (and so on), this last event was coded as a response. Because they engaged in a lengthy dialogue of this sort, the majority of utterances of the child were coded as responses, rather than as spontaneous (see below: Table 7.11 and Figure 7.4), despite the fact that he might have been taking the initiative during the exchange. This coding may be partially responsible for the correlation between the Child On-task Response and Adult On-task Response (r=.417, p=.016)- see below.

Figure 7.3 Child On-task Spontaneous verbal behaviour.



On-task Verbal Response

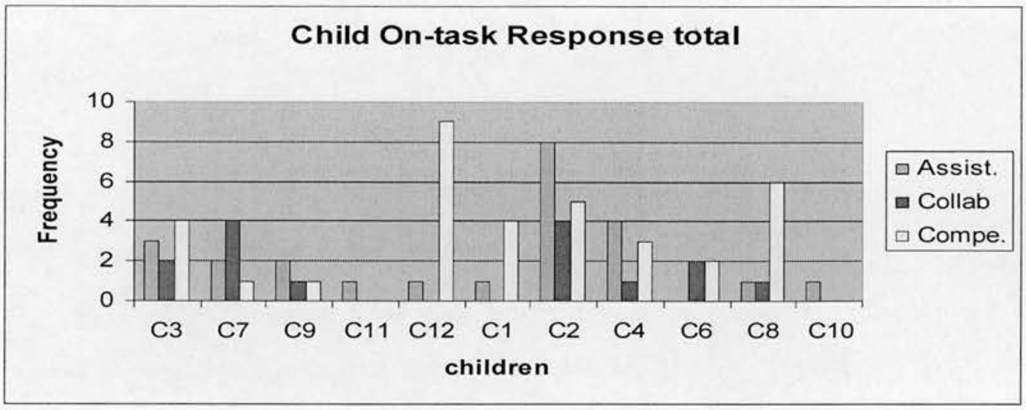
When looking at the children's verbal responses under the 3 conditions of playing (see Table 7.11 and Figure 7.4), there was a slightly higher level of responsiveness in the assistive condition in the group that started with collaboration (mean: 2.5 vs. 1.8). However, as one individual case (C2) contributed disproportionately to the mean, and with such small numbers, it is not possible to draw any strong conclusions. This pattern was reversed in adult's On-task Spontaneous behaviour (see Table 7.10, p 164.) which could be due to the fact that feedback, turn taking calls and help have been clustered together in relation to this verbal behaviour.

Table 7.11 Child On-task Response total.

group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
Assist.	3	2	2	1	1	1	8	4	0	1	1	2.2	1.8	2.5
Collab	2	4	1	0	0	0	4	1	2	1	0	1.4	1.4	1.3
Compe.	4	1	1	0	9	4	5	3	2	6	0	3.2	3.0	3.3

It was also very evident that there were fewer verbal responses in the collaborative condition (1.4 vs. 2.2 and 3.2), although the adult's behaviour was relatively consistent for each child throughout the conditions. Again, this could be due to the adult's role in the collaboration allowing for the scaffolding of the child's playing abilities, such that each needed less assistance as a consequence, whereas verbal offers of assistance in the other conditions were an important component of the adult's On-task Spontaneous behaviour, creating more opportunities for the child to respond.

Figure 7.4 Child On-task Response behaviour.



Off-task verbal Spontaneous and Response

Tables 7.12 and 7.13 show that levels of Off-task speech were, in general low. This was possibly predictable when looking at off-task responses, since the adult intentionally did not initiate much off-task dialogue, minimizing the opportunities to respond.

Table 7.12 Child Off-task Spontaneous.

group	Assistive					Collaborative				
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist	2	0	0	0	0	0	1	5	0	0	0
Collab	0	0	0	0	1	0	0	0	1	0	0
Compet	0	2	0	1	0	3	2	4	2	0	0

Table 7.13 Child Off-task Response.

group	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
assist	0	0	0	0	0	0	0	1	0	0	0
collab	0	0	0	0	3	0	0	1	0	0	0
compet	0	0	0	0	0	0	0	0	0	0	0

With respect to Spontaneous Off-task speech, it is clear that child C4 was more prone to Off-task speech than the rest of the children in his group (collaborative first), increasing the overall total. Six of the children showed Off-task Spontaneous speech in the competitive condition, whereas only three did so in the assistive condition and 2 in the collaborative.

7.3.2 Assistance

There was a significant difference among conditions in frequencies of adult Offer Help behaviours ($F_{(32)}$= 8.699, p=.001). The adult offered very little help (mean = 0.5) in the collaborative condition (see Table 7.14). This could be explained by the scaffolding taking place during play, as mentioned before, when reporting on child behaviours. In the other two conditions, the adult's behaviour was consistent, offering a similar amount of help in each condition for any given child. This shows in general that some children needed more help than others. However, as can be seen from Table 7.14, those who were offered help in collaboration were not necessarily those who received more help overall.

Table 7.14 Adult Offered Help.

group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
Assist.	7	3	2	1	9	4	3	4	1	5	9	4.4	4.4	4.3
Collab	0	0	0	0	1	2	0	2	0	0	1	0.5	0.2	0.8
Compe.	4	3	2	5	11	5	1	3	1	10	8	4.8	5.0	4.7

Table 7.15 shows the frequency with which the adult actually provided help. There were situations when the adult gave help without being requested, despite a behaviour protocol that dictated that help should be offered before actually providing it. At times, however, it was judged as better to provide such assistance where there were doubts about the child's understanding of the rules, and on other occasions, in order to maintain the child's motivation. It is also possible, of course, that the adult made mistakes when following the protocol.

Table 7.15 Adult Gave Help.

group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
Assist.	1	1	1	3	5	0	0	0	0	2	3	1.5	2.2	0.8
Collab	1	0	0	0	0	0	1	0	2	1	2	0.6	0.2	1.0
Compe.	1	0	0	0	1	3	1	0	0	0	0	0.5	0.4	0.7

What can be drawn from this data is that the adult was more inclined to provide assistance spontaneously in the Assisted condition, but also in the first condition taking place. For example, assistive group holds 5 of 7 cases in the Assistive condition (its first) and collaborative group presents 4 of the 5 cases where this behaviour occurred in the Collaborative condition (its first).

7.3.3 Eye contact

Although differences were not significant, the adult looked more at the child in the Collaborative condition (mean: 8.5) than the Assistive (mean: 6.5), and also than in Competitive mean: (7.9) (see Table 7.16, over). This could have been caused by the fact that to be consistent with the protocol, the adult had to look at the child every time she spoke to him, and there were more opportunities to do so by indicating turns, of which there were most in the Collaborative condition and the least in the Assistive. .

Table 7.16 Adult Look total.														
group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
Assist.	3	3	6	6	12	10	4	13	5	3	7	6.5	6.0	7.0
Collab	6	6	10	7	8	13	8	13	9	6	8	8.5	7.4	9.5
Compe.	10	5	9	4	8	11	3	6	9	10	12	7.9	7.2	8.5

The number of times children looked at the adult was not correlated to the adult's behaviour. Except in the case of child C6, who engaged in frequent eye contact during the Competitive condition, there was little response in general (see Table 7.17).

Table 7.17 Child Look total														
group	Assistive					Collaborative						Mean		
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10	Tot	As.	Coll
As.	0	0	0	1	0	0	1	0	2	1	1	1.1	0.8	1.3
Coll.	1	0	4	0	1	0	0	0	2	0	0	0.1	0.0	0.2
Com.	0	0	3	0	0	2	2	0	8	3	0	0.9	0.4	1.3

7.3.4 Help

None of the children asked for help in the Collaborative condition, four of them did it in the Assistive condition and only two in the Competitive (see Table 7.18). There was no difference between the groups A and C. In the Collaborative version of the game, there was less need for help since the child already new the rules (group A) or the adult was anticipating problems by giving help (group C). These two factors add to the facilitating factor of the adult playing.

Table 7.18 Child Asked for Help Spontaneously.											
group	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
assist	0	1	0	4	0	4	0	0	0	0	1
collab	0	0	0	0	0	0	0	0	0	0	0
compet	0	0	0	0	1	0	2	0	0	0	0

It is surprising that only 2 children asked for help in the Competitive version, considering the fact that children were trying to win, were familiar with the protocol, the adult, and the game, and that they had been reminded that they could ask for help any time without being penalised for it.

Whether children asked for help after being prompted was not correlated with the help offered by the adult (see Table 7.19, over). Apart from the case of child C4, who accepted almost all the help offered in the three conditions, most children seemed reluctant to accept help. In three cases, C1, C3 and C7, children accepted help about a third of the times it was offered to them. Interestingly, the three children (C9, C6 and C11) who did not request help after being prompted, where offered help less than three times in each condition (except C11 who received more help in competition).

Table 7.19 Child Asked Help Prompted.

group	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
assist	2	1	0	0	1	1	2	4	0	0	1
collab	0	0	0	0	0	0	0	1	0	0	0
compet	1	1	0	0	0	2	0	3	0	3	0

From the four remaining cases, three accepted help in the Assistive condition and only one in the Competitive condition. Only one of them, C2, accepted an amount of help proportional to the offers. The rest were offered assistance several times in both conditions but did not accept it.

7.3.5 Waiting

The Competitive condition required the child to be waiting while the adult completed a full puzzle. Since the protocol instructed the adult to match the child's playing ability, the length of time to complete a puzzle was constrained by the fastest child's solution so far. This lead to a certain number of games where the child was observant. Table 7.20 shows some of the behaviours of the children during Competitive playing.

Table 7.20 Child waiting in Competitive condition.

group	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
helped	0	yes	yes	yes	0	0	0	yes	0	0	0
On-task spont	0	4	2	12	7	2	0	3	4	7	0
Off-task spont	0	0	0	0	0	0	1	11	8	2	0

Only child C11 was not distracted at all during his waiting time, which is to say, he did not display any verbal or non verbal Off-task behaviour, and he was also the child who displayed more On-task Spontaneous speech. Children were participative in general, with eight of them producing spontaneous On-task related speech, and only four, Off-task speech (three of whom produced On-task speech).

But there was one more behaviour that took place unexpectedly: four children provided help to the adult. This was more surprising since they knew they were competing against her. Three of the four children were in group A, which meant that the most recent version played was Collaborative.

7.4 Discussion

This initial analysis has shown that the Adult's behaviour was consistent with the protocol, but it is difficult to draw clear conclusions. The variability of performance afforded by the game added difficulty to the context. Also, it is always the situation when using small samples that a particular case may change the global result. In the group used here, there were different 'individual cases' depending on the variable being analysed.

On/Off Task

The analysis of the adult On/Off Task speech shows consistency in the spontaneous behaviour, with little off task speech, and limited response to the child's off task speech. The slight difference between group A and C needs to be confirmed through more complete data analysis (duration included).

The adult responses presented more variability, which may be related to the child's number of attempts. One of the reasons for not responding, as the protocol indicated, to all child's utterances was that the adult did not notice them due to the lack of clarity or the low volume. Another reason was trying to avoid frustration in the child by asking him to repeat several times what he said. This provoked an Off Task conversation with one child who asked why the adult did not understand him. The relevant issue is that there were the missed opportunities to respond to the child. Children with ASD tend to find it more difficult to initiate interaction in general, speech in particular, and those attempts may be weaker than in typically developing children. Ignoring the child's spontaneous speech may not discourage the child's natural tendency to speak, but it is not likely that will encourage it.

Doing the Collaborative condition before the Assistive did not seem to affect children's On-task Spontaneous Speech. There was more of this behaviour in the Collaborative than in the Assistive condition, with the least in the Competitive. This points at the Collaborative condition as an environment where more On-task Spontaneous Speech can occur, which is to say, it offers the best conditions to foster this behaviour.

There was also more Off-task Spontaneous Speech in the Competitive condition. A possible explanation could be that children had been focusing on the experiment for near 15 minutes by the time they started the Competitive version, and started to be a little more distracted even when it was their turn.

The children seemed slightly more responsive in general in group C, but this is not conclusive. Surprisingly, the least responses were in the Collaborative version. This can be explained (as before) by the supporting role of the adult in the game. The adult moves may correct the wrong moves of the child, and the puzzle is solved without the child feeling neither stuck, nor needing help. The adult's behaviour seems consistent throughout, but the nature of her utterances may be different: in an assistive role it includes offers of help, feedback and turn taking calls. The offers of help prompt a verbal response more than the turn taking calls, which are simply informative and do not require response. The Collaborative version is based on turn taking, with more turn taking utterances, but less need for help.

Within a communication-rich environment, where the child needs something that is out of reach – knowledge in this case-, and communicating with the adult is the only way to obtain it, there are more opportunities for spontaneous communication (Potter and Whittaker, 2001). In this context, the Collaborative condition was not the best environment, with the Assistive and Competitive versions, where the child solves the puzzles alone, being more "communication-rich" environments. This appears to contradict the previous finding about On-task Spontaneous Speech, of which there were greater values in the Collaborative condition. This requires detailed analysis about the nature of the utterances, it may well be the case that there are more On-task utterances in the Collaborative version, which are not requesting help. In fact, it was the case that some children produced turn taking calls, or even help, as well as comments, in this condition.

Assistance

Regarding the level of assistance provided, apart from providing less in the Collaborative condition, it was noticed that the adult provided help without first offering a few times. The adult tended to volunteer assistance early on the session (regardless of the condition) but more so in the Assistive condition, probably feeling more entitled to do so. This behaviour may have interfered with the opportunities of the children to respond and accept or reject, thus showing responsiveness or making a stronger case of rejecting help.

Moreover, data shows some reluctance to receive assistance in general, accentuated by the fact that children were advised repeatedly that the amount of help would not count in the result, and were offered help when having difficulties. There may be more than one reason to explain this. First, most children seem quite engaged in the game, and talking may distract them from their primary goal. Second, they may feel competent enough to solve the puzzle and asking for or accepting help may spoil their personal satisfaction. On the other hand, none of them explicitly indicated not to be assisted when the adult provided help without asking. These factors would confirm two things: one, the game is engaging and the experiment design gives children a sense of mastery, which makes the experience enjoyable and positive; and two, children with ASD behave just like any other child in this aspect. However, this is just an assumption, and a further study would confirm it.

Eye contact

The adult seemed to look more at the child in the Collaborative version, probably due to the turn taking, but the frequencies of children's looks at the adult were too low to draw any conclusions. However, the fact that they were low could add one more proof of children with ASD avoiding eye contact. But this could be unfair here, since most of the adult's looks were engineered in the protocol, and her natural behaviour would have been to look at the screen and talking sideways. Again, only a comparison with typically developing children could clarify this.

It was also observed that there was a little increase in looks throughout the session, with children looking at the adult a few more times as time progressed. Only group C showed an increase in the Competitive condition, which would suggest that starting with Collaboration may promote looking more. The number of children and the frequencies of their 'looks' are not sufficient to make such a claim.

Waiting

As interesting as the comparison of the three experiment conditions was, it was no less interesting to observe some of the behaviour that took place while the children were waiting for their turn in the Competitive version.

Different children had to wait more depending on how the game was happening but five of them were distracted very little, and six were clearly distracted, which is to say they were not focused on what was happening on the screen. And there were some off task comments too (four children). Even so, eight children were engaged enough to say something related to the task. All of this was expected, but four of the children also provided help, which was unexpected, since they were aware of the competition. Three of them were in group A, so their most recent version was Collaborative. Again, the sample is too small to make any claims on this. It seems necessary to increase the number of subjects to find out.

7.5 Summary

This chapter presented the findings of a study of social interaction patterns in children with autism when playing a jigsaw puzzle game on a computer whilst being assisted, collaborating and competing. Eleven children of 7 to 11 years old participated in the study. The main findings were:

- The adult was consistent, initiating a similar amount of On-task speech in the three conditions for any given child.

- The adult tended to provide more help without offering it first at the beginning of the session, for both groups, but also in the Assistive condition.
- The adult missed some opportunities to respond to the child.
- The adult seemed to look more at the child in the Collaborative version.
- Children displayed more On-task Spontaneous Speech in the Collaborative condition.
- Children displayed more Off-task Spontaneous Speech in the Competitive condition.
- Children were more responsive in general in group C although the least responses were in the Collaborative version.
- The Collaborative version created more opportunities for turn taking utterances, but less for requesting help.
- The Assistive and Competitive versions, where the child solves the puzzles alone, created more opportunities to request help.
- Children showed reluctance to receive assistance in general
- Children looked at the adult a few more times as time progressed. Only group C showed an increase in the Competitive condition.
- Six children were clearly distracted while waiting in the Competitive condition.
- Four of the children also provided help, and three of them were in group A, so their most recent version was Collaborative.

7.6 Further work

Results show that it is necessary to increase the sample in order to have enough data to make a stronger case for the initial conclusions presented here. If this sample was composed of typically developing children, then it would be possible to discern whether a pattern of behaviour is consequence of the experiment design or of the nature of autism.

Chapter 8: Social interaction in children with autism and typically developing children in collaborative vs. competitive playing

In this final study the social interaction between child and adult was observed during collaborative and competitive playing. The study involved children with autism as well as typically developing children, which allowed one to observe the two groups under both conditions. Twenty two children aged 6 to 11 years, (11 with ASD and 11, typically developing children (TD), played a jigsaw puzzle game with an adult on a computer under an assistive, collaborative and competitive condition, for 5 minutes at a time.

8.1 Research questions

The study presented here intended to observe the social interaction of two different groups of children under different computer game conditions and find out whether there are differences between of children with ASD and typically developing children. Under these conditions, the following questions arise:

- Which children remain focused On-task longer?
- Which children initiate more interactions?
- Which children seek more eye contact?
- Which children respond more to experimenter?
- What do children do when they are waiting turn?
- Do the children´s social skills influence interaction?

8.2 Methodology

8.2.1 Overview

The study followed the same method described in Chapter 7, involving one session of 25 minutes in which children played under three different conditions, following a predefined protocol including a script of the researcher's behaviour and playing strategies. The sessions with the ASD group were carried out first, as described in Chapter 7, followed by the sessions with the TD group. Participants within each of these groups were divided into two matched subgroups each starting with either the Assisted or Collaborative version first, continuing with either Collaborative or Assisted, and then finishing with the Competitive version. As indicated in the previous chapter, the whole session was video recorded in order to obtain 5 minutes of footage in each condition.

8.2.2 Considerations

Although sessions with the ASD group took place at their school, the sessions with the TD group were arranged with the parents to fit in the after-school activities of the child and were carried out at their homes. Both, school and home are familiar environments for children, who could feel equally comfortable with the experience. The setup as well as the researcher's behaviour pattern remained the same as described in Section 7.2.

Also, although it was a one off session for both groups, the TD group sessions took place after the ASD group, which might have had an impact in the experimenter's behaviour, such as feedback, eye contact or assistance. Another factor which might have influenced the researcher´s behaviour was the different traveling time (2.5 hours -one way for the ASD group).

8.2.3 Study Participants

The participants were 22 children 6-11 years old, 11 typically developing children and 11 with a diagnosis of ASD. The children with ASD had difficulties in communication and social interaction but were able to become involved in a computers-based activity. All children were also familiar with the experimenter, after spending approximately 30 minutes during cognitive assessment. The profiles of the participants with ASD can be seen in Table 7.1, while the TD participants' profiles are shown in Table 8.1 (see also Figure 8.1). Parents of the TD children completed the social items of the Vineland questionnaire, used to measure social level as in previous studies (see Chapter 4, section 4.3.5). Although the classroom version was used, and the measures may not be as reliable as a more comprehensive evaluation, they were deemed appropriate enough for matching purposes.

Table 8.1 TD Participants' profiles. (Chronological, and social age given in years:months)

Child	Age	Social	IQ	Group
T1	10:5	5:9	75	assistive
T2	12	12:3	55	collaborative
T3	10:8	15:0	63	collaborative
T4	8:7	10:10	66	assistive
T5	7:2	3:8	59	assistive
T6	9:11	6:10	54	assistive
T7	8:1	5:9	68	collaborative
T8	7:2	4:11	61	collaborative
T9	6:11	15:6	67	assistive
T10	9:4	8:0	71	collaborative
T11	8:9	12:0	69	assistive

Figure 8.1 Children's profiles.

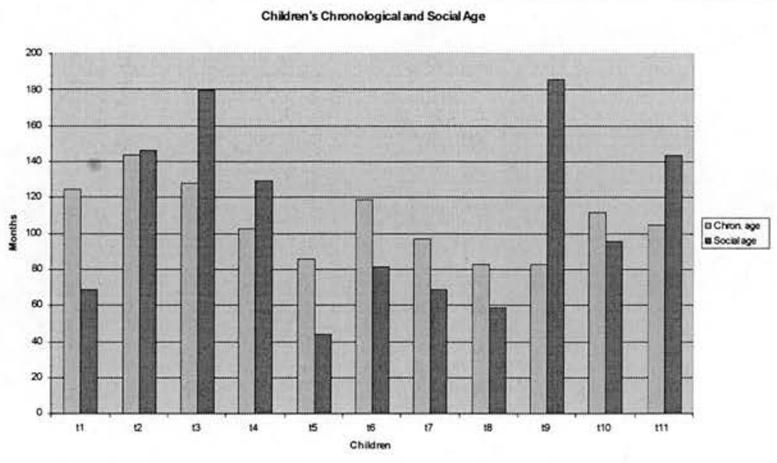


Table 8.2: TD Group matching			
Group	Age	Social	IQ
Assistive first	8:3 (6:11-10:5)	9:9 (3:8-15:6)	63 (54-69)
Collaborative first	9:5 (7:2-12)	9:2 (4:11-15)	64 (55-71)
Total Average	8:10 (6:11-12)	9:6 (3:8-15:6)	63 (54-71)

Table 8.3: Group matching			
Group	Age	Social	IQ
ASD	9:7 (8:5-11:5)	2:9 (1:6-3:9)	62 (49-72)
TD	8:10 (6:11-12)	9:6 (3:8-15:6)	63 (54-71)
Total Average	9:3 (6:11-12)	5:11 (1:6-15:6)	63 (49-72)

Table 8.2 shows the TD group matching in order to start with the assistive or collaborative condition first. Table 8.3 shows the matching of the ASD and TD groups, with a similar range of chronological age and IQ, and a clear difference in social age, as expected.

Access

The participants with ASD were approached through an informative letter to the head teacher of their school, explaining the nature of the study. Permission was granted by the relevant authorities and parental consent requested as described in Chapter 7. TD children were contacted through a parent of one of the participants, known to the researcher, and they were all from a similar social and cultural background. The parents of the TD children were given an informative letter and signed the same consent form than the parents on the ASD group.

8.2.4 Procedure

Details of the procedure, including the protocol and structure of the session, have been discussed in Section 7.2.4. All the sessions of the ASD group were carried out at the children's school, always accommodating to children's schedules to minimize disruption. The sessions with the TD group took place at their homes outside school time, after the sessions with the ASD group had been completed. In each case (both ASD and TD children) there was a one-off session in which the three different versions of the jigsaw puzzle game were played at the computer for 5 minutes each.

8.2.5 Video Analysis

A description of recording setup, software used and coding system used for video analysis can be seen in section 7.2.5. The sessions with the TD group provided 33 video recordings for analysis, which, together with the ASD group, added up to 66 video recordings.

Table 8.4 Inter-observer reliability (TD).

	% agreement frequency	kappa	% agreement duration	kappa
Verbal behaviour	88	.84	97	.94
Non verbal behaviour	68	.59	82	.74
Total	78	.71	89	.84

A second observer blind to the purpose of the study scored 10 % of the 33 TD group's videotapes (see section 7.2.5). Although there was 68% of agreement in the frequency of the Non Verbal behaviour, slightly under the 70% considered adequate, the total, including the Verbal behaviour (88%) was 78%, indicating that the coding by the first observer was reliable (see Table 8.4).

Table 8.5 Inter-observer reliability (ASD and TD).

	% agreement frequency	kappa	% agreement duration	kappa
Verbal behaviour	86	.81	95	.92
Non verbal behaviour	78	.71	88	.81
Total	82	.76	91	.86

Taking the coding data from the ASD group (see Section 7.2.5), when the coding for both groups were put together (see Table 8.5), then the measures for Non Verbal behaviour increased to 78%, increasing the total to 82%. Since this included the coding of more videotapes, these measures can be considered more reliable.

8.3 Results

As in the previous study (Chapter 7), the analysis focused on the frequency of certain events, looking at On/Off-task behaviour, opportunities for eye contact, opportunities to interact based on the amount of assistance from the adult partner.

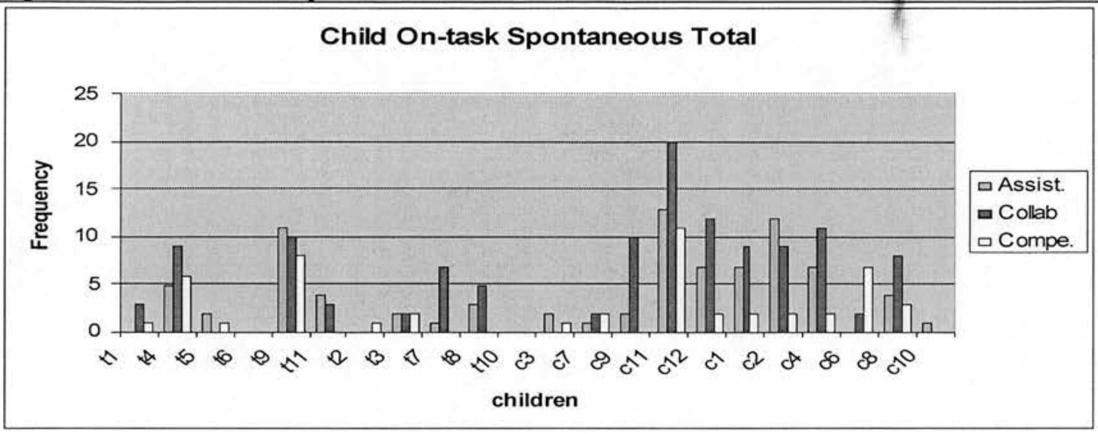
8.3.1 On/Off-task behaviour

Child

It is very clear that children in the TD group displayed less On-task Spontaneous speech than the ASD group (see Table 8.6 and Figure 8.2, below and over). In both groups, there was more On-task Spontaneous behaviour in the collaborative condition, followed by the assistive condition. The condition they started with did not seem to have an effect in the behaviour. When looking at adult responses (Table 8.11, p. 183), it did not show the same level of difference than the child initiations, which is explained by the protocol which demanded that the adult be very responsive to the child.

Table 8.6 Child On-task Spontaneous total (Frequency)											
group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	0	5	2	0	11	4	0	2	1	3	0
Collab	3	9	0	0	10	3	0	2	7	5	0
Compe.	1	6	1	0	8	0	1	2	0	0	0
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	2	1	2	13	7	7	12	7	0	4	1
Collab	0	2	10	20	12	9	9	11	2	8	0
Compe.	1	2	0	11	2	2	2	2	7	3	0
	Mean Frequency										
ID	TD		ASD		Assist		Collab		Total		
Assist.	2.5		5.1		4.3		3.4		3.8		
Collab	3.5		7.5		6.3		4.8		5.5		
Compe.	1.7		2.9		2.9		1.7		2.3		

Figure 8.2 Child On-task Spontaneous total.



The responses of the children depended on the spontaneous behaviour of the adult, which was prescribed by the protocol to be as homogeneous as possible in both groups and through the different conditions. In contrast, the pattern of children's responses was different (see Table 8.7 and Figure 8.3, below and over). In the TD group there was less On-task responses than in the other group, being most noticeable in the collaborative condition, with only 4 children responding at all while there were 7 that responded in the ASD group. Only 2 of 22 children did not respond at all in the assistive condition, 5 in the competitive and 11 in the collaborative.

Table 8.7 Child On-task Response total (Frequency)

group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	2	2	3	1	2	3	1	3	0	1	2
Collab	0	1	0	0	1	0	1	1	0	0	0
Compe.	0	5	5	2	0	4	1	0	2	2	2
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	3	2	2	1	1	1	8	4	0	1	1
Collab	2	4	1	0	0	0	4	1	2	1	0
Compe.	4	1	1	0	9	4	5	3	2	6	0
	Mean Frequency										
ID	TD		ASD		Assist		Collab		Total		
Assist.	1.8		2.2		2.0		2.0		2.0		
Collab	0.4		1.4		0.8		0.9		0.9		
Compe.	2.1		3.2		2.8		2.5		2.6		

Figure 8.3 Child On-task Response total.

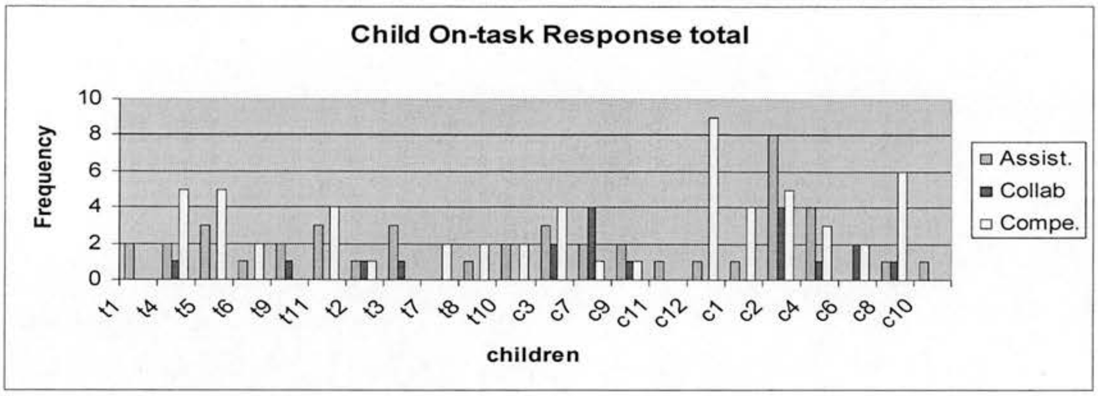


Table 8.8 (below) shows that only 2 children of the TD group initiated Off-task speech, whereas in the ASD group there were 8 children, of which 3 actually showed this behaviour in two conditions. There was less Off-task speech in the collaborative condition, 0 in the TD group and 2 children in the ASD, with three cases in the assistive condition and 6 in the competitive condition of this group.

Table 8.8 Child Off-task Spontaneous total. (Frequency)

group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	0	0	0	0	0	1	0	0	0	0	0
Collab	0	0	0	0	0	0	0	0	0	0	0
Compe.	0	0	0	0	2	0	0	0	0	0	0
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	2	0	0	0	0	0	1	5	0	0	0
Collab	0	0	0	0	1	0	0	0	1	0	0
Compe.	0	2	0	1	0	3	2	4	2	0	0

The Off-task responses were fewer than the Off-task adult initiations (see Table 8.9, over). They also appear not to be direct consequence of an adult Off-task behaviour, which may be due to them being an Off-task response to an adult behaviour not coded as Off-task.

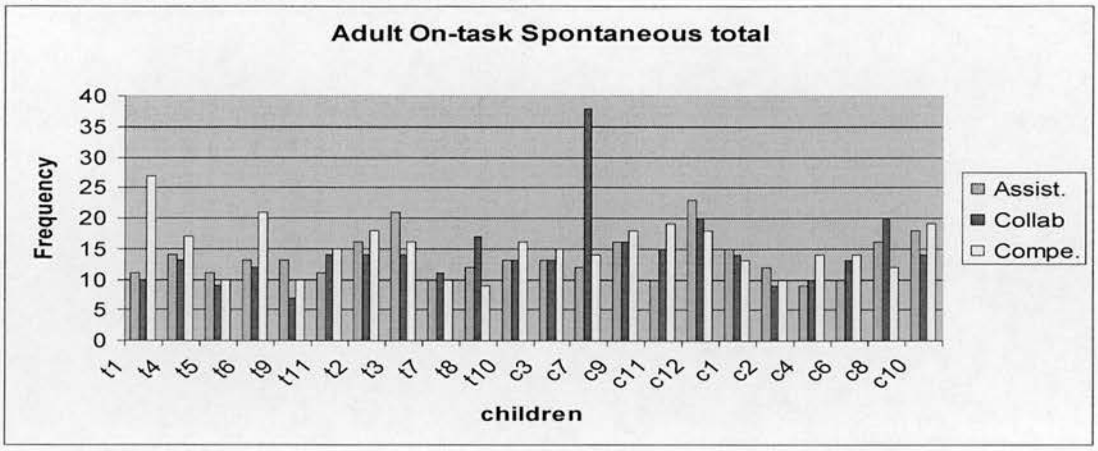
Table 8.9 Child Off-task Response total. (Frequency)											
group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	0	0	0	0	0	0	0	0	0	0	0
Collab	0	0	0	0	0	0	0	0	0	0	1
Compe.	0	0	0	0	0	0	0	0	0	0	0
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	0	0	0	0	0	0	0	1	0	0	0
Collab	0	0	0	0	3	0	0	1	0	0	0
Compe.	0	0	0	0	0	0	0	0	0	0	0

Adult

In general terms, adult On-task behaviour was consistent through the conditions, so each child received a similar amount of On-task speech in the three conditions, even if different children received a different amount, although there seems to be a slightly more variability in the TD group. There were two exceptions to this as child C7 had a lot more adult On-task Spontaneous speech in the collaborative condition and child T1 had more in the competitive condition (see Table 8.10 and Figure 8.4, below and over). In the case of child C7, the adult felt that she needed to remind him of his turn more frequently than the rest of the children, which means that she may have deviated from the desired homogeneous behaviour. On the other hand, child T1 did have some difficulties with the puzzles in the competitive condition, which lead the adult to offer help several times, according to the protocol, increasing her number of Spontaneous behaviours.

Table 8.10 Adult On-task Spontaneous total. (Frequency)											
group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	11	14	11	13	13	11	16	21	10	12	13
Collab	10	13	9	12	7	14	14	14	11	17	13
Compe.	27	17	10	21	10	15	18	16	10	9	16
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	13	12	16	10	23	15	12	9	10	16	18
Collab	13	38	16	15	20	14	9	10	13	20	14
Compe.	15	14	18	19	18	13	10	14	14	12	19
	Mean Frequency										
ID	TD		ASD		Assist		Collab		Total		
Assist.		13.2		14.0		13.4		13.8			13.6
Collab		12.2		16.5		15.2		13.5			14.4
Compe.		15.4		15.1		16.7		13.7			15.2

Figure 8.4 Adult On-task Spontaneous total.



It may also appear to be a slightly fewer instances of behaviour defined as On-task Spontaneous in the collaborative condition in the TD group than in the ASD group. There was more On-task Spontaneous behaviours during competition in both TD (4/6) and ASD (3/5) subgroups that started with the assistive condition. On the other hand, in the TD group there was a little more On-task Spontaneous speech during the assistive condition of the collaborative subgroup than in the assistive, which appears strange since being their second game they should need less assistance.

Table 8.11 Adult On-task Response total. (Frequency)

group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	1	6	5	3	11	7	1	4	2	4	1
Collab	4	3	0	0	5	1	0	0	3	6	0
Compe.	2	5	4	3	6	5	3	2	1	2	1
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	4	2	0	7	6	5	8	7	1	0	2
Collab	1	0	3	12	9	4	5	5	2	3	0
Compe.	2	2	1	2	12	4	6	3	4	7	0
	Mean Frequency										
ID	TD		ASD		Assist		Collab		Total		
Assist.	4.1		3.8		4.7		3.2		4.0		
Collab	2.0		4.0		3.5		2.5		3.0		
Compe.	3.1		3.9		4.0		3.0		3.5		

Adult responses (see Table 8.11) depended on the child's initiations. In general terms, there was more variation of the adult responses for any given child depending on the condition. The most clear difference was that there were less responses in the TD group (no response at all in 5 cases) than in the

ASD (only 2) during the collaborative condition. Both groups showed a variety of responses among the children.

Off-task behaviour was very limited, happening spontaneously with 4 children of the TD group and 2 of the ASD group. Interestingly, the adult responses to Off-task behaviour took place with 2 children of the TD group and 7 of the ASD group, which indicates more spontaneous Off-task behaviour from the children in the last group.

8.3.2 Assistance

Not all children asked for help when they clearly needed it. Five asked for help during their first game (4 in assistive and 1 in collaborative) and three during competition, with only one asking for help during assistive and competitive conditions (see Table 8.12). These data could be analysed looking at the number of games played, to see whether those who asked for help the most were the ones who actually needed it the most. Asking for help during the competitive condition was allowed and would have given an advantage to the child who did it, but the majority did not.

Table 8.12 Child Asked for Help Spontaneously. (Frequency)

group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	0	0	2	0	0	2	0	0	0	0	0
Collab	0	0	0	0	1	0	0	0	0	4	0
Compe.	0	0	1	0	0	0	1	0	0	0	0
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	0	1	0	4	0	4	0	0	0	0	1
Collab	0	0	0	0	0	0	0	0	0	0	0
Compe.	0	0	0	0	1	0	2	0	0	0	0
	Mean Frequency										
ID	TD		ASD		Assist		Collab		Total		
Assist.	0.4		0.9		0.8		0.5		0.6		
Collab	0.5		0.0		0.1		0.4		0.2		
Compe.	0.2		0.3		0.2		0.3		0.2		

Table 8.13 (over) shows that children in both groups seemed to accept help when prompted in the assistive condition. The little appearance of accepted help during collaboration is probably due to a lesser need cause by adult intervention through playing together. There were 8 children in the TD group who accepted help during the competitive condition whereas there were only 4 in the ASD group who did the same.

Table 8.13 Child Asked Help Prompted. (Frequency)											
group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	0	0	1	1	0	0	1	3	0	1	1
Collab	0	0	0	0	0	0	0	0	0	0	0
Compe.	0	1	2	2	0	3	1	0	1	2	1
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	2	1	0	0	1	1	2	4	0	0	1
Collab	0	0	0	0	0	0	0	1	0	0	0
Compe.	1	1	0	0	0	2	0	3	0	3	0

Table 8.14 Adult Offered Help. (Frequency)											
group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	0	6	5	4	9	4	2	7	4	6	1
Collab	0	0	0	0	0	0	0	0	0	0	0
Compe.	6	5	3	7	5	8	6	0	4	6	3
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	7	3	2	1	9	4	3	4	1	5	9
Collab	0	0	0	0	1	2	0	2	0	0	1
Compe.	4	3	2	5	11	5	1	3	1	10	8

The adult offered help spontaneously when needed, according to protocol (Table 8.14). The behaviour was consistent for any given child, in general terms, for both groups, which means that some children appeared to need more help than others, with more variation among the ASD group. It was also in this group that some help was offered during the collaborative condition. The fact that the adult participated in the game providing solutions made it less necessary to help verbally, as indicated in the previous study.

Table 8.15 Adult Gave Help Spontaneously. (Frequency)											
group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	0	4	3	1	1	1	1	0	2	1	0
Collab	0	2	2	0	1	0	0	1	0	4	0
Compe.	3	0	0	0	0	0	0	0	0	0	0
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	1	1	1	3	5	0	0	0	0	2	3
Collab	1	0	0	0	0	0	1	0	2	1	2
Compe.	1	0	0	0	1	3	1	0	0	0	0

There were cases when the adult provided help spontaneously, as shown in Table 8.15. It was expected to happen more often in the first game of each child, in order to help the child learn the rules and maximize his motivation. The ASD group shows exactly that, with more adult help being given during the assistive condition of the assistive subgroup, and more help given during collaboration in the collaborative subgroup. On the other hand, the TD is slightly different, there is more help in the assistive condition in the assistive subgroup, but there is also more help in the collaborative condition. However, the number of occurrences is small, so there are no conclusions to be drawn from this.

8.3.3 Eye contact

Table 8.16 (below) shows that the adult looked at the child more or less the same number of times in both groups during the assisted and competitive conditions, with some more looking in two cases of the TD group, one for each condition (T9, T1). It is striking that there were also two cases (T10 and T4) when the adult did not look at the child, which is not to say that she did not interact (many times, she talked to the child while looking at the screen). In the collaborative condition, the adult appears to have looked more at children in the ASD group. In any case, the difference between conditions was significant, ($F(2,63) = 19.993$, $p<.05$), probably driven by the Adult Look Spontaneous ($F(2,63) = 17.047$, $p=.000$).

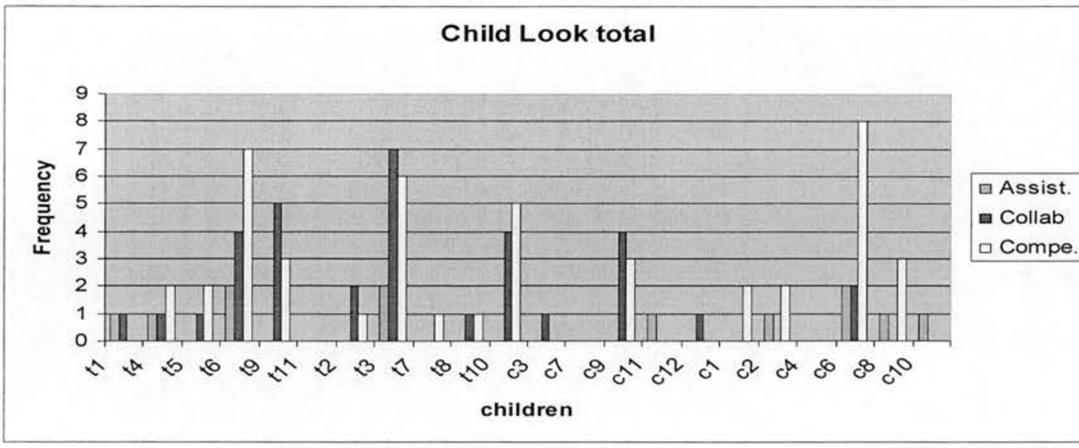
Table 8.16 Adult Look total. (Frequency)

group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	9	7	6	8	22	6	7	10	7	7	0
Collab	8	8	2	5	8	6	4	5	5	5	4
Compe.	20	0	8	14	14	7	11	8	5	7	9
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	3	3	6	6	12	10	4	13	5	3	7
Collab	6	6	10	7	8	13	8	13	9	6	8
Compe.	10	5	9	4	8	11	3	6	9	10	12

Table 8.17 Child Look total. (Frequency)

group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	1	1	0	2	0	0	0	2	0	0	0
Collab	1	1	1	4	5	0	2	7	0	1	4
Compe.	0	2	2	7	3	0	1	6	1	1	5
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	0	0	0	1	0	0	1	0	2	1	1
Collab	1	0	4	0	1	0	0	0	2	0	0
Compe.	0	0	3	0	0	2	2	0	8	3	0
	Mean Frequency										
ID	TD		ASD		Assist		Collab		Total		
Assist.		0.5		0.5		0.5		0.6			0.5
Collab		2.4		0.7		1.6		1.5			1.5
Compe.		2.5		1.6		1.5		2.6			2.1

Figure 8.5 Child Look total.



On the other hand, children looked at the adult very few times in comparison, especially in the assisted version (see Table 8.17 and Figure 8.5). In the collaborative and competitive conditions, 9 children from the TD group looked at the adult, with only 4 and 5 children from the ASD group did it in each condition respectively. Interestingly, the differences between conditions were also significant ($F(2,63) = 6.524$, $p=.005$).

8.3.4 Waiting

During the competitive condition children waited for the adult to complete her puzzle and their behaviour was coded. In the TD group 7 children were distracted (looked away or displayed other Off-task behaviours), and in the ASD group 10 children were distracted (see Table 8.18).

Table 8.18 Child waiting in Competitive. (Frequency)

group	Assistive						Collaborative				
ID	T1	T4	T5	T6	T9	T11	T2	T3	T7	T8	T10
Assist.	1	0	9	0	1	0	0	0	1	2	0
Collab	4	4	3	0	5	1	0	0	0	0	1
Compe.	1	0	0	0	1	1	0	0	1	0	1
	Assistive					Collaborative					
ID	C3	C7	C9	C11	C12	C1	C2	C4	C6	C8	C10
Assist.	0	0	0	0	0	0	1	11	8	2	0
Collab	0	4	2	12	7	2	0	3	4	7	0
Compe.	0	1	1	1	0	0	0	1	0	0	0

In both groups, the majority remained involved in the game, either by paying attention but also those who were distracted did show more On-task Spontaneous speech. There were children who displayed

Off-task Spontaneous speech in both groups, 5 in the TD and 4 in the ASD. But it was the ASD group where there was more On-task Spontaneous speech, with 8 children with higher values than the 6 children of the TD group.

Another behaviour that took place was the children providing help to the adult. There were 5 from the TD group and 4 from the ASD, three of each happening in the assistive subgroups, which means that 6 children had just done the collaborative condition.

8.3.5 Correlations

There were some correlations of interest, apart from the most obvious ones such as that between the child's On-task look spontaneous and On-task look response (r=.308, p=.014), since it would seem logical that those who look more spontaneously also look as a response. For example, both the child's On-task look spontaneous (r=.353, p=.005), and On-task look response behaviours (r=.272, p=.002) were correlated with Adult look total, which implies that when the child looked more, so did the adult and vice versa, with the child's Look Total being correlated to the Adult Look Total (r=.39, p=.002). It is not possible to know whether this was due to the Adult's role as being responsive to the child, or the influence of her spontaneous eye contact on the child.

Also interesting was the correlation found between the child's On-task social spontaneous behaviour and the Adult look total (r=.305, p=.015). The most likely interpretation is that the adult looked at the child if he was talking to her. It could be added, from direct observation of the videotapes, that the adult looking at the child did not prompt his speech.

Social age was correlated with Off-task social spontaneous (r=-.273, p=.031), Off-task social Total (r=-.280, p=.026), Social Total (r=-.254, p=.044), Prompted Help (r=-.341, p=.006) and Adult Look Total (r=-.295, p=.019). It might be the case that the Off-task social behaviour influenced the Social Total, but it seems that the better the social skills the less Off-task behaviour is seen. On the other hand, there were some correlations between Social age and other variables that were expected but not found On-task social Spontaneous, On-task social response, Look spontaneous, Look response.

8.4 Discussion

8.4.1 On/Off-task behaviour

The adult seems to have maintained a more or less consistent behaviour, apart from some exceptional instances, in both the On-task and Off-task Spontaneous behaviour. There were some differences between the adult behaviour in the two groups, but those were small. It is only when looking at the children's behaviour that differences between the groups appear, and these are not necessarily what one would expect.

The fact that in the TD group there was a little more On-task Spontaneous speech during the assistive condition on the collaborative subgroup, cannot be explained without further analysis of data, since that was the second condition and should have required less assistance. It could be due to more positive feedback rather than assistance.

The adult responses were more varied because they depended on the children's initiations, and those were also heterogeneous. The adult was less responsive in the TD group, but children in that group also initiated less, so the adult behaviour was coherent. The TD group also initiated less Off-task speech, and as a consequence, the adult responded more to the ASD children's Off-task speech.

Children in the TD group showed less On-task spontaneous speech than those in the ASD group, which was surprising. It may be explained as the TD group trying to solve the puzzles by themselves, with more confidence in their own skills to do it, therefore not asking for help, which is a major component of the On-task Spontaneous speech. But more analysis is required to understand this, if at all possible.

What was expected and found, was more of the On-task Spontaneous category of behaviour in the collaborative condition, regardless of what condition they started with, in both groups (TD and ASD). This is an interesting outcome when looking at levels of help offered and requested by the child in the collaborative condition. What makes this On-task speech of a different nature needs more analysis.

The TD group was less verbally responsive to adult On-task speech than the ASD group, and this was most clear in the collaborative condition. This behaviour is consistent with the previous spontaneous behaviour, and it reinforces the idea that the TD group was less verbal than the ASD group or put in different words, that the ASD group was more verbal.

The assistive condition generated more responses and the collaborative condition generated the least. The first might be explained by assuming that children were aware of the assistive role of the adult and responded to her for that reason, however, there is not enough data to support this argument. It is not strange there was less response in the collaborative condition because there was less adult On-task Spontaneous speech. Accepting that the adult was providing help through playing, thus making the interaction less verbal during the collaborative condition, then the other learning situation was the assistive condition, which was more verbally based, thus generating then more verbal responses.

It was clear from the Off-task Spontaneous speech results that children in the ASD group were more distracted than in the TD. This may be explained by a shorter attention span or difficulty in concentrating in children with ASD. However, it may also be the fact the ASD group was more verbal in general, including this behaviour, which is consistent with the previous behaviours. Similarly, there was less Off-task speech in the collaborative condition, probably because of generating less speech in general. But there was more Off-task speech in the competitive condition, which was always the last one and the children may have been tired or bored by then, getting more easily distracted.

8.4.2 Assistance

The adult offered help consistently, and data shows that some children appeared to need more help than others with the ASD presenting a wider range. A detailed analysis of the profiles may clarify whether this wider range has some explanation in terms of variability within the group (e.g. more extreme values in IQ or social skills). There was minimal help offered during collaboration, probably due to the scaffolding role of the adult playing with the child and therefore facilitating the game. Considering that the adult showed as much On-task Spontaneous speech in the collaborative condition, and that the number of games played was similar, generating the same amount of praise and feedback as in the other condition, then it can be assumed that the nature of the speech was more focused upon turn taking.

The results also showed that the adult provided help directly in several occasions, against the protocol instructions of offering help first. This tended to happen in the first game of the child, showing that the adult adapted the general rules to maximize child's motivation, as instructed in the protocol.

All children were reluctant to ask for help. Only 7 children did actually ask for help, and further analysis is required to know if those were the children that needed it the most. They were more likely to accept it in the assistive condition, where the role of the adult as assistant was emphasized. However, TD children seemed to be more willing to accept help when prompted to do so in the competitive condition than the ASD group. This can be interpreted in two ways: first, the TD children noticed that it would be advantageous to use help to speed their solutions, and second, the ASD children preferred the challenge of solving things on their own. A third possibility is the combination of both interpretations, but there is not enough data to choose one over the others.

8.4.3 Eye contact

The protocol required the adult to look at the child every time she spoke to him. There was not a major difference between the groups, except in the collaborative condition where the adult looked more at the ASD children. Having played a similar number of games in both groups, and not needing verbal help as much in this condition, it can be assumed that the adult looks were related to turn taking calls. This does not necessarily mean that children needed to be reminded of their turn, but that the adult decided to make those calls. It may have been that the adult acted based on previous knowledge and not reacting to what was actually happening. Further analysis should clarify this aspect.

In general terms, children did not look too much at the adult. This may have been a consequence of their engagement with the game, or even the hypnotic qualities of the screen which make it easier to remain looking at it than to look elsewhere. There were more children from the TD group who looked at the adult in the collaborative and competitive version. This would be consistent with the autistic features that refer to avoidance of eye contact, but the cases are too few to assume that this difference of significance.

Interestingly, both groups of children looked the least in the assistive condition. An interpretation could be that the adult provided verbal explanations about what was happening on the screen, and this required the child to be looking at it in order to understand, and the rest of the time was concentrating on playing. A feature of the game is that time is ticking unless you have just finished a game, at the moment the ′next′ button is clicked, timer starts again, so children probably feel they have to focus on the game to do their best, leaving little time to waste.

8.4.4 Waiting

The time spent by children waiting for their turn in the competitive condition generated a variety of behaviours. The ASD group appeared to be more distracted than the TD group, which is consistent with expectations relating to a shorter attention span within the autistic population. However, both groups displayed a similar number of Off-task Spontaneous speech. Considering that the TD group has been less verbal in general, it is surprising that they should have shown a proportionally higher level of 'verbal' distraction (Off-task speech). To add to the confusion, those children who appeared more distracted also displayed more On-task Spontaneous speech. As the competitive condition was the last one to be played, it is likely that the children were tired and more prone to distraction, but at the same time, the outcome of the adult's game was important for their own victory, which may have kept them engaged throughout the waiting period. This was the intention when designing the game and experimental protocol.

Finally, a few of the children in both groups provided help to the adult, despite knowing that they were competing. Whether the reason was boredom or a helpful nature prompted by adult example in the collaborative versions, the fact is that there was a similar number in each group, 5 in the TD and 4 in the ASD.

8.5 Summary

This chapter presented the findings of a study of social interaction patterns in typically developing children and children with autism when playing a jigsaw puzzle game on a computer whilst being assisted, collaborating and competing. Twenty two children of 6 to 11 years old participated in the study. The main findings were:

- The adult was consistent with her On/Off-task Spontaneous speech through the conditions and across the groups.
- The adult provided more help without offering first in the first game.
- The adult provided little help in the collaborative condition.
- The adult looked more at children from the ASD group during the collaborative condition.
- Children showed more On-task Spontaneous speech in the collaborative condition, and least in the competitive.
- Children with ASD showed more On-task Spontaneous speech than the TD group.
- Children were more responsive to On-task adult speech in the assistive condition.
- Children in the TD group were less responsive to On and Off-task adult speech.
- Children showed less Off-task Spontaneous speech in the collaborative condition, and more in the competitive.
- Children in the ASD group showed more Off-task speech, and were in general more verbal than the children in the TD group.
- Children were reluctant to ask for and receive help.
- Children in the TD group accepted more help during the competitive condition.
- Children looked less at the adult in the assistive condition.
- Children in the TD group looked at the adult more than the ASD group in the collaborative and competitive condition.
- Nine children provided help to the adult during their waiting time in the competitive condition.
- Children in the ASD group appeared more distracted but also displayed more On-task Spontaneous speech during their waiting time in the competitive condition.

There are three main issues in these findings. First, all children seemed to enjoy the game and were fully engaged throughout the session, and those who appeared more distracted were also the most participative during their waiting time. Second, all children seemed reluctant to ask for and receive help, despite of being reminded several times that this would not affect their score. These are consistent with the literature that states that computers are engaging, motivational and provide an opportunity to develop a sense of mastery (Murray, 1997).

Finally, children in the TD group appeared to look at the adult a little more than those in the ASD group. Although this would be expected because people with autism tend to avoid eye contact, the number of occurrences was small in both groups, because the nature of the game kept children engaged with what was happening on the screen, and this tends to be true for computer games in general. In contrast, the TD group appeared to be less verbal, which goes against expectations. This may show that even typically developing children speak little when at the computer. However, these could be a consequence of the nature of the game, and both groups playing with a different game will show different patterns of speech frequency and eye contact. In the meantime, these findings suggest that we should not assume that, when playing computer games, the speech and eye contact displayed by a child with ASD is caused by the autism and not by the environment.

8.6 Game Summative Evaluation

An evaluation is called summative when it is carried out after the product has been developed (Preece et al., 1994). The results in performance by the real users in the real context of use provide an insight in the effects of the design. The performance measures gathered in this case were the speed at which children solved the jigsaw puzzles and how many of them they managed to solve in each of the conditions. If the results were similar in the pilot group and ASD group, then it would be possible to conclude that the game did not make demands which children with ASD cannot meet. This would have to be interpreted with care because the protocols used have been slightly different.

The main aspect of the protocol that could have an impact on the performance of the children was the level of assistance. With the pilot group, assistance was offered at the beginning of each condition, whereas in the study described in Chapter 7, assistance was offered after every three errors. This effect may have been reduced by the fact that not all the children in the ASD group needed help, and from those who needed it, only a few accepted it on some occasions. However, comparing the performance of a typically developing group under the same conditions of the ASD group would allow one to rule out the protocol as a cause of differences in performance. Before discussing the findings it is important to point out that statistical analysis (one-way ANOVA) showed no significant differences between the groups, thus the present analysis focused on descriptive aspects of the results.

8.8.1 Group speed

First of all, it needs to be clarified that the number of puzzles solved depended not only on the speed of the child but also on the amount of time given to do it. Since these performance observations are interlinked with the studies reported earlier (see also Chapter 7) which required at least five minutes of play in each of the three conditions, children were allowed to finish the puzzle they were solving by the time the five minutes were up. This meant that if a child was slow in solving a puzzle, but had just started solving one a few seconds before time was up, he may have been given a lot more time than a child who solved the puzzles fairly quickly. Table 8.19 shows that there was an heterogeneous performance across the groups, varying from those who solve only a few puzzles (minimum 4) to those who solve more (up to 19), because they are faster.

Table 8.19 Group speed.			
Group speed	Pilot group	ASD	TD
Number of puzzles solved	6-12	4-17	8-19
Speed range (seconds)	33-242	32-246	24-296
Individual difference range (seconds)	54-163	62-175	48-178
Average speed (seconds)	84	88	84
Median speed (seconds)	72.60	75	75

Speed range in Table 8.19 shows the fastest solution of any child within a given group, together with the slowest solution within the same group, which may be of the same child or any other. Data show a similar range of responses, varying from 24-33 seconds in the fastest cases to 242-296 in the slowest. What these indicate is that the three fastest children took a similar amount of time, and the same holds for the three slowest children, with the group of TD children having the broadest speed range with the fastest and slowest of the three groups, making it the group with the most heterogeneous performance.

Table 8.20 Difference fastest-slowest in three groups, in increasing order.											
Pilot group (secs)	54	60	62	63	68	73	75	81	83	101	163
ASD (seconds)	62	71	77	92	100	101	125	125	127	165	175
TD (seconds)	48	48	59	91	109	115	128	142	151	178	251

It might be more informative to find out if the difference between the fastest solution of a puzzle by a given child and his slowest is a measure with some regularity among the groups, as it appears in the Table 8.20. Again, the smallest difference ranged from 48 to 62, whereas the biggest ranged from 163 to 178 seconds. This shows, first of all, that children in all groups seemed to perform within similar ranges, with the same variability between the individual fastest and slowest game. Secondly, the group with the most extreme values is the TD. And finally, some puzzles took more time to solve than others. The design of the experiment guaranteed that there had to be a learning curve, due to the difficulty of the rules. Data showed most of the slowest responses occurred in the first game played, as expected.

In general, the average speed in each group was similar, and although the ASD and TD groups had the most different values, the median speed happened to be the same. Regarding speed in general, it could be said that children in all groups performed in a similar pattern.

8.8.2 Fastest

When looking at the fastest individual solution, results were very close in the pilot and ASD group, with the fastest solution in the TD group. However, an individual result does not provide information about the group. Taking into consideration the range of fastest solutions of all individuals, Table 8.21 shows that the group with the most variation was the ASD, with the pilot group having the least variation. As for the average fastest solution, results were similar with the fastest average and median in the TD group.

Table 8.21 Fastest individual.			
	Pilot group	ASD	TD
Fastest individual solution (seconds)	33	32	24
Fastest range (seconds)	33-73	32-121	24-90
Fastest average (seconds)	49.73	46	44
Fastest median (seconds)	46	44	38

Table 8.22 Fastest children (ordered by speed).												
	Pilot group (secs)	33	35	37	39	44	46	49	53	66	72	73
	ASD (seconds)	32	34	35	36	39	44	44	48	53	59	121
	TD (seconds)	24	25	29	33	33	38	45	47	52	68	90

The table 8.22, shows all the fastest results of the individuals. The colour indicates the results obtained in the competitive condition, which was the case of 25 of the 33 individuals. This could be explained by the added motivation of the competition, but it could have been a consequence of the learning process that took place during the previous conditions. Interestingly, the ASD group had slightly fastest responses than the pilot, with one individual being significantly slower, which affected the range of responses but not the average of the group.

8.8.3 Slowest

The slowest solution was achieved by a TD child (see Table 8.23, over). This in its own may not be surprising since the results, in general, appeared in a wider range in this group. However, the fact that this took place in the competitive condition might point out some factor other than learning curve. The same thing happened to three more children in the competitive condition and it may be due to the difficulty of the images: they appeared randomly distributed and sometimes it might have been hard to identify the first few correct pieces, and if the child did not ask for help then it would have taken longer to solve the puzzle.

Table 8.23 Slowest individual.				
	Pilot group	ASD	TD	
Slowest individual solution (seconds)	242	246	296	232
Slowest average (seconds)	137.8	148.5	178	150.8
Slowest median (seconds)	116	164.5	164.1	162.5
Slowest range (seconds)	93-242	94-246	72-296	72-232

In any case, the observation of when this 'slowest' solutions took place is more enlightening. As it can be seen in Table 8.24 (below), the grey colour represents the first game played in the session, regardless the condition. darker grey represents the first game of the second condition (regardless which one they started with, assistive or collaborative), and white represents any game during the competitive condition. Interestingly enough, none of the slowest marks obtained by the four children during the competitive condition actually happened in the first game of that condition. What the table shows is that the slowest speeds happened in 23 out of 33 cases during the first game. This can be explained by the fact that during the first few games children were learning the rules of the game.

Table 8.24 Slowest game.											
Pilot group (secs)	93	99	103	107	109	116	126	145	147	156	229
ASD (seconds)	94	105	112	131	148	160	169	171	201	228	246
TD (seconds)	72	86	88	116	148	177	180	198	211	232	296

8.8.4 Assisted vs. Collaborative

The analysis of the slowest game required the analysis of the first game of all children in detail. In the table 8.25 results are presented in increasing order, the grey colour represents those who did the assistive condition first, whereas the white represents those who did the collaboration first. A glance at the fastest side of the table shows a bias towards the collaborative condition, which is to say, those who did the collaborative condition first were a little faster than those who did the assistive condition first. This can be due to the scaffolding role of the experimenter, who acted as a partner in the collaborative condition and may have been able to place pieces a little faster than the child.

Table 8.25 Speed in the first game.												
											average	median
Pilot (secs)	75	93	99	103	107	114	116	145	147	156	229	125	114
ASD (secs)	69	79	94	105	112	137	148	157	201	228	246	143	137
TD (seconds)	47	72	73	81	107	116	177	180	198	211	232	136	116

When comparing the three groups, the average speed of the pilot group was the fastest, followed by the TD and then the ASD group, with similar values. The difference between the ASD group and the other two appears to be greater when looking at the median. However, data show a similar pattern within each of the groups, which is consistent with the previous results.

Table 8.26 Average speed in first game.			
	Pilot group	ASD	TD
Assisted (seconds)	144.2	183.4	153.3
Collaborative (seconds)	111	102	115

If data were broken down into assisted and collaborative conditions (see Table 8.26), then it would appear that the ASD group was distinctively slower than the other two groups in the first game of the assistive condition and slightly faster than the other two in the collaborative condition. In fact, all groups were faster in the collaborative condition, which may be due to the experimenter's scaffolding mentioned before. The most extreme values in the ASD condition could be due to the higher difficulty of some individuals in understanding and, therefore, applying the rules, since they were delivered verbally. However, it could have been due to just a couple of children being a little unlucky with their first game.

8.8.5 Conclusion

The TD group seemed to have a slight broader range of performance, in general, but the pattern of performance in the three groups was similar. The slowest games tended to occur in the first game of all, regardless the condition, as it could be expected when learning a new game, although those who did the collaboration took a little less time, maybe due to the contribution of the experimenter. These results, together with the lack of statistically significant differences, seem to point out that the performance of the three groups was similar, despite the differences in design and type of children.

Chapter 9: Conclusions

This thesis aimed to investigate whether computers could play a role in enhancing social interaction in children with autism. As evidenced in the literature overviewed in chapter 2, current developments allow for a very sophisticated use of technology in educational settings, both with mainstream pupils and with pupils with special educational needs. This use is very costly both in terms of knowledge and resources, however, and its proven benefits are still limited and under research. There is a trend of using computers in education (as well as in many other fields) just because it is possible, without any real evaluation of the benefits and costs.

Undoubtedly it would sometimes be easier for a teacher just to make a quick drawing, photocopy it and give it out in an art class, rather than learning to use a drawing program, or a scanner and a printer, both of which have to be available in the first instance and may require troubleshooting. The reality is that significant financial resources are being directed towards providing schools with computers in the UK and Spain, but frequently without consideration of the continuing cost of maintenance or, more importantly, the need for adequate teacher training if these are to be put to best use. If a piece of technology could be used as is, with no need for sophisticated software or skill requirements (i.e. no need for teacher training), then it would be more likely to be used frequently; in the long term, the benefits could be higher in practice, even if in principle potentially smaller. In the current situation, computer equipment is frequently underused and its true potential therefore not being fully realised.

Even in settings and contexts where computers are widely used, they often serve functionally simply as an electronic or digital version of a more traditional teaching technology: e.g. using a word processor instead of a typewriter or pen and paper; searching on the internet instead of in the library; presenting with Power Point instead of on a blackboard. The real potential of computers in education lies in what could be done with computers that could not be done without them. So far this is an area of application investigated only within the research field and likely to take some time to transfer to the school setting. True innovation is not so likely to come from purchasing the latest computer equipment but from creative uses of those computers and from making full use of the additional educational routes they afford.

In this thesis, given the current state of this field of research, the principles of minimum cost and maximum efficiency drove the series of studies reported here. This required the use of resources that met the research requirements but were already easily available to teachers. In facing design decisions, the predominant factor was to preserve simplicity.

9.1 Game design issues

What this thesis tried to achieve was to gain some insight about how best use computers in order to provide opportunities for social interaction in children with ASD. This specific combination of medium and goal had its origin in the fact that children with autism are typically interested in computers. This makes them an ideal environment for joint learning and interpersonal interaction as they are widely available both at school and at home and they are highly motivating to most children. The computers used here were not the latest model and the games developed were not full of multimedia features, quite the contrary in fact.

The user protocol is what makes the studies different from those which have gone before. This was specifically designed to ensure that there were as many interaction exchanges as possible and that it was an enjoyable experience for the children involved. When necessary, software was designed which paid special attention to the needs of the users as well as to meeting the experimental requirements. The end product was stripped of any features that might cause confusion or distraction, or could interfere with the results, with a very simple layout of the Noughts and Crosses (Fig. 4.2) and a Jigsaw Puzzle (Fig. 6.9). When developing computer applications for special populations such as those with learning difficulties, this simple 'look' is a natural consequence of catering for their needs. It should not be mistaken for design driven by concerns of cost or as reflecting low-level programming. The software used in this research has been created using the same careful process of design, analysis and evaluation used for others developers in the field to create applications with much more sophisticated looking layouts, and the end product of this process is what that analysis and consideration dictated it was needed.

9.2 A comparison of findings from all the computer-based research conditions

Before commenting on the findings of this thesis, it might be helpful to review and compare the various computer-based conditions which were applied in Studies 1-4 in terms of their interaction regulations, the task demands and how competitive the task conditions were. This should provide a common framework within which to interpret the outcomes and to attempt some synthesis of these.

The computer-based conditions used two different games, Noughts and Crosses, and a Jigsaw puzzle, and were presented as five different game approaches:

- Chapter 4: *Noughts and Crosses, computer-based.* The child and experimenter played against each other on the computer (as well as on paper).

- Chapter 5: *Noughts and Crosses, against computer.* The child played alone against the computer, with or without a partner providing positive feedback on performance.
- Chapter 7: *Jigsaw assistive*: the child played alone at the computer, with the experimenter assisting. *Jigsaw collaborative*: child and experimenter collaborated to solve the jigsaw puzzle. *Jigsaw competitive*: child played against experimenter.

In the discussion above, games have been classified accordingly to the role of the experimenter, the type of interaction and the presence or absence of any competitive element. The experimenter, a partner in all the sessions, was either supportive only (providing feedback, praise and/or help), a collaborator, or an opponent. The interaction is defined here as voluntary if the child could choose to engage or not in it, such as when playing against the computer, and as involuntary if it took place without the child's intention, for example, when playing Noughts and Crosses against the experimenter, whose moves therefore directly affected game choices of the child. Although a communicative interaction of this type is not at the same level of social competency as turn taking or being aware of another (because the experimenter's moves affect the child's options), this required 'some' level of interaction and was built into the game and so does not rely on of the social ability of the child's partner.

The game approaches are also described as either highly competitive, when there is a perceived opponent such as the experimenter or the computer, and as low in terms of competitiveness, when there is not an external opponent. It was difficult to assess in a more fine-grained way the level of competitiveness required to help distinguish the approaches on this metric. They vary from the clearly competitive situation of the child playing against the experimenter, to the clearly non-competitive context of the collaborative approach. There is some level of competition when the child is playing against himself and even in the collaborative situation there is some level of competitiveness in that the joint team is playing against the computer. The case of the child solving the jigsaw puzzle on his own has been defined as having medium competitiveness because here the emphasis was not on speed but on completion of the task, thus there was not a strong feeling of competing against either time, the computer or himself. Despite these limitations, this classification was nevertheless thought to have some utility when choosing a particular approach for an individual based on its element of competitiveness, bearing in mind that for some children with ASD a highly competitive environment may be motivating, whereas for others it may be stressful.

Tables 9.1 and 9.2 (over) show all the game approaches presented in terms of the above factors, ordered from top to bottom in terms of interaction demands and degree of competitiveness respectively. The rationale for this classification was to identify the approaches with maximal interaction and minimal stress due to competition.

Table 9.1: Sorted by interaction.			
Game approach	*Role of partner*	*Interaction*	*Competitiveness*
Jigsaw collaborative	Collaborator	Involuntary: Partner's moves affect child's	Low
Noughts&Crosses computer based	Opponent	Involuntary: Partner's moves affect child's	High
Jigsaw competitive	Opponent	Mixed (only involuntary for turn taking)	Medium
Jigsaw assistive	Supportive	Voluntary	Low
Noughts&Crosses against computer	Supportive	Voluntary	High

Table 9.2: Sorted by competitiveness.			
Game approach	*Role of Partner*	*Interaction*	*Competitiveness*
Noughts&Crosses against computer	Supportive	Voluntary	High
Noughts&Crosses computer based	Opponent	Involuntary: Partner's moves affect child's	High
Jigsaw competitive	Opponent	Mixed (only involuntary for turn taking)	Medium
Jigsaw assistive	Supportive	Voluntary	Low
Jigsaw collaborative	Collaborator	Involuntary: Partner's moves affect child's	Low

The above classifications can be used not only to analyse the results of the studies presented here, but also to select the most appropriate approach if the games were going to be used to promote social interaction with a particular child. This could be done by adhering to the protocol initially chosen and then moving step-wise through them, increasing the level of interaction or competitiveness required until the child is prepared to play with an untrained peer.

In that context, it has to be pointed out that a highly competitive situation may be alleviated by demanding little interaction, thereby reducing stress levels. Each of the situations may suit a particular child at a particular time, depending on what they are able to cope with. Ideally, games should always be played with a partner, but at a very early stage in intervention, some children may need to play on their own at the computer, while they become familiar with the presence of their partner (adult, peer). The initial games could be Noughts & Crosses against the computer or assisted Jigsaw puzzle, with the choice determined by whether the child enjoyed competition or whether there was a need to reduce stress levels by minimising the competitive element of the game being played.

The next stage would be to increase the interaction demands by one step, by requiring the child to take turns with an 'opponent' in a competitive Jigsaw game. In this game, when the opponent plays, the child does not need to do anything and interaction is minimized. On the other hand, playing Noughts

& Crosses demands constant interaction because the child's moves are affected by his partner's choices. If the child needs less competitive pressure, then a collaborative Jigsaw puzzle game could be selected instead, as it offers the same amount of involuntary interaction but is not so competitive.

9.3 Findings

9.3.1 Study 1: Computer vs. paper

The first experimental study, presented in Chapter 4, looked at the interaction between the experimenter and the child while playing Noughts and Crosses using two different media: paper and computer. The results were not conclusive, but there appeared to be at least some differences between the two versions which were informative. There was, for example, significantly more On-task Social behaviour, both Spontaneous and Response, in the paper version of the game, with the highest values of On-task Social behaviours emerging in the paper-based sessions which had been preceded by a computer-based session.

It was also clear that very individual characteristics and situations may have influenced the results. What the findings of Study 1 showed was that although most children were more focused on the task and more interactive on the paper version, there were some individuals who focused more when playing the game at the computer. This again emphasizes the need to develop intervention programs which are individualized in order to choose the tool that will provide the greatest number of opportunities for interaction for a particular child.

While the paper version led to more On-task Social behaviour in Study 1, the findings did not suggest that computers were necessarily detrimental for social interaction. On the contrary, all children displayed On-task Social behaviours while at the computer. This, when taken together with the likely inherent advantages of using computers with children with ASD (see Chapter 2), justifies the use of computers for social interaction purposes as presented here: even when they may not be the best option for a given child, sometimes the motivational aspects may be enough to keep the child interacting for a longer period than with other approaches which might otherwise be more advantageous for that child.

Overall, both the paper and computer versions of the Noughts and Crosses game seemed to be equivalent in terms of the task (number of games played) and the adult's adherence to protocol. The experiment was designed in fine detail and having both versions of the game available would make it possible for other researchers to replicate the study, something which is not always possible in the field of autism research. In addition, the game provides controlled opportunities for promoting a range of interactions, in the form of explanation of the rules, turn taking, 'blocking' and praise. These constraints on the other player allow the game situation to be easily analysed if used as a pre- or post-test.

One special individual case observed in game playing, excluded from the analysis because it was not completely video-recorded due to technical problems, revealed another element which might need to be considered: the flexibility of the paper version. This allowed this child to change from using noughts to crosses in playing his turn, under the protocol instruction of maximizing motivation. This individual child then had the session with a computer and as this could not make such allowances, he was annoyed by it, although he still managed to complete the session. It is not possible to know if the child would have been similarly upset if this had happened in the paper version. In any case, it appeared that for this child restrictions were more tolerable while at the computer. This might have been worth considering in the future, when trying to teach him to cope with frustrating situations.

9.3.2 Study 2: Individual vs. Partner

The second study, presented in Chapter 5, looked at the children playing against a partner at the computer (as reported in the first study), comparing this with their responses when playing alone at the computer while the adult sat by their side providing feedback. The primary findings were of similar responsiveness in both conditions, with more On-task Independent behaviour when playing alone and more Off-task behaviour when playing with a partner. In general, there was more Social behavior, both On and Off-task, when playing with a partner. Also important were the clear differences among individuals, consistent with the previous study.

It was not surprising that children playing alone against the computer displayed more On-task Independent behavior, as they did not have to wait for turns or accommodate to the partner's moves. For the same reason, the finding that children displayed more social behaviors with a partner is an expected consequence of the game design: as seen in Table 9.1 above, there is a 'built in' requirement for involuntary interaction. Interestingly, however, the video analysis coding revealed another type of behaviour, which although positive, might not have been an effect of the presence of a partner in the options available to the child. It is possible that the child may have considered the moves by the partner as if they were being made by the computer, and, thus, to ignore the partner despite the built-in turn taking process, accepting a certain waiting period as part of the game without being 'aware' of the other player. The fact that a mouse exchange was involved, however, and the consistent social interaction provided by the partner, ensured that there was at least a physical and verbal presence of the 'other player', in addition to her 'presence' on the computer screen (when taking her turn).

In a practical setting, this highlights the possibility that two children apparently sharing a computer game may simply be playing alongside each other without actually being fully aware of each other: in some games it is possible to use different parts of the keyboard – normally clearly separated - to control the game, making it easy for the child to concentrate on his keys and their effect on the screen, with everything else happening on screen being caused by what he may think is his 'true' opponent, the computer itself. Although this scenario of coping with playing alongside somebody else may be an achievement for a particular child, it is clear that is not necessarily as rich a setting as other more interactive contexts may be. On the other hand, there are still opportunities for interaction even when the partner is just sitting alongside, as shown in the study presented. In some cases, this less intrusive presence of the partner may be easier for the child to tolerate or may allow the child to concentrate better on the task at hand. If that were the case, for a given child, setting up an easier computer-based task may foster more social interaction, whereas a more complex task may need all the mental resources of the child and preclude any episodes of social interaction.

Off-task Social behavior

The fact that playing with a partner led to more Off-task Social behavior raised a new question: Is Off-task Social behaviour undesirable? There is no single or straightforward answer to this question. When trying to develop interaction with someone who is not inherently interested in social interaction, as in children with autism, then any kind of interaction is positive. In practice, that would mean that even when there is a certain task to be completed, if the child started a conversation or exchange about any other topic and was a lot more communicative, then there might be some value in responding actively to this behaviour, even at the cost of not completing the task. This has two immediate consequences: the child is building a relationship with the partner, and is practicing social skills. The interchange also allows the partner some insights into what kind of things are of specific interest to the child.

There is a considerable interaction potential here, even when behaviour is Off-task, although much depends on where the child is and what the goals of the session are, whether academic or social. In the scenario just described, any interaction is positive as a starting point, but, if the child is in a more advanced stage of social interaction, then Off-task Behaviour may need to be discouraged in order to maintain focus on the task.

There could be a risk of training a child to be 'Off-task' if sessions with a strong 'social' goal take place in the normal school setting, where most children are required to be 'On-task'. Using a different room or classroom area, and making it clear that they were going to 'play' at the computer, as opposed to 'work' are possible routes towards preventing this kind of problem arising.

9.3.3 Study 3: Collaborative vs. Assistive

The third study presented in this thesis (see Chapter 7) observed the social interaction patterns of children with ASD when playing a jigsaw puzzle game on a computer under three contrasting conditions: being assisted by an adult, collaborating with an adult and competing against an adult. The data from this study showed that children were generally reluctant to accept assistance, although in the Assistive and Competitive versions, which required the child to solve the puzzles alone, more opportunities to request help were built-in to the design. In contrast, it seems that the Collaborative version created more opportunities for turn taking interactions, and fewer for requesting help. A possible interpretation of these findings is that by playing at the same level of the child, effectively functioning as a 'peer', the researcher therefore supported the child's towards completing the puzzle. Data showed that children displayed more On-task Spontaneous Speech in the Collaborative condition, and more Off-task Spontaneous Speech in the Competitive condition, with six children clearly distracted and four seeking help in this session.

Overall, the Collaborative version of the jigsaw puzzle game proved to be more conducive to task related behaviors whereas the Competitive version produced more distractions. The cause of these may relate more to limitations of the design than to child factors, however, and be due to longer waiting times in the Competitive condition (discussed below in Section 9.4.6) than in the competitive nature of the game itself. It was this waiting time that provided the opportunity for the children to offer help spontaneously, regardless of whether their intention was to avoid boredom or to maintain any collaboration carried over from the previously experienced condition - in several cases, this happened with children who had completed the jigsaw under the Collaborative condition before experiencing the Competitive condition.

The reluctance of most children to accept help was perhaps surprising given that they were told that the help received would not affect their scores. It was frequently the case that children were offered help repeatedly when they were stuck, but seemed reluctant to accept it. This might be explained by a need for a sense of personal achievement, with this diminished if somebody else contributes to their 'results'. It was the subjective impression of the researcher that children accepted help only when they felt they could not solve the problem, or, in some cases, when they felt that they could benefit from it, in terms of speeding up their game. Although providing support during the game may be positive and necessary for some children, others may feel alienated by persistent offers of help if the inherent drive is to challenge themselves. It is one more factor to control for any individualized intervention: rather than offering help throughout a task for instance, it may be more effective to factor in the level of the task when offering help.

9.3.4 Study 4: ASD vs. TD children's interactive behaviours

The last empirical study, reported in Chapter 8, compared the responses of the children with ASD to those of typically developing children playing under the same conditions: playing a jigsaw puzzle game on a computer whilst being assisted, collaborating and competing.

As in the previous study, the children with ASD produced most On-task Spontaneous speech in the collaborative condition, most Off-task Spontaneous speech in the competitive condition, and most responsive to the adult in the assistive condition. These results from an enlarged ASD sample confirm both that the collaborative condition fostered more task-related speech and that the competitive condition allowed more distractions.

Despite the distractions, presumably caused by the waiting time between turns, the competitive condition created opportunities for the unexpected help offered to the adult partner by nine of the ASD and TD children. This contrasts sharply with the general resistance to accepting help demonstrated in both groups (as shown in Study 3). Although the waiting time required under the collaborative and competitive conditions could be a built-in weakness in the design, it nevertheless apparently resulted in an environment in which the children could be more relaxed and relate more freely to their partner, be it in the form of asking for help, of producing more On or Off-task speech, or of trying to distract them from the task.

When comparing the findings from the two contrasting groups of children, the first unexpected finding was that the children with ASD displayed more On-task Spontaneous speech in the competitive condition than the typically developing group, even during their waiting times, as well as producing more Off-task speech in all conditions. TD children were less verbal in general and less responsive to the adult speech, although they made somewhat more eye contact with the adult than the autistic children.

What the results show is that children with ASD were more verbally interactive than the TD group while working on the jigsaw puzzle. This could be a consequence of the higher levels of distraction evidenced in the ASD group, or of the higher levels of concentration displayed in the TD group. Regardless of the reason, it seems that even TD children display little speech while playing at the computer. In this aspect therefore, TD children's low level of interaction was more in line with the expectations for autistic children, whereas the behavior of the children with ASD was closer to the expectations for the TD children. It is possible that a different type of game, one that involved a more complex problem-solving process requiring discussion, planning and reflection, could have yielded very different results. However, the subjective impression during the study was that, when playing at the computer, children with ASD and TD were not that different. Given the concerns over the use of computers with children with autism, this is perhaps important to note.

9.4 Limitations to the research

9.4.1 Experimenter's influence

In all the studies, in order to make the intervention consistent across experiments, there was a strict protocol that specified how the researcher should play the game, what she should say to the child and how frequently. Data analysis showed that the experimenter's behaviour was indeed consistent in these respects across the sessions. It was later, during video analysis, that it was noticed that the experimenter was in fact displaying qualitatively different levels of expressiveness with children. In fact, she appeared more subdued when working with quieter children, speaking at a lower volume, and with more subtle gesturing. This did not appear to affect the amount of interaction, because the script was followed, but showed rather that the experimenter was adopting the communicative style of the child inadvertently. This was not part of the protocol, nor was it considered as a potential factor beforehand.

There are two possible consequences to this variation in experimenter's behaviour. On one hand, the fact that the experimenter communicated using the same level of expressiveness that the child was displaying may have made it easier for the child to take in the message, as it was delivered at a level of input they could handle without feeling overloaded, a common problem in some children with ASD (as outlined in Chapter 1). On the other hand, children with ASD may need extra interaction, including 'exaggerated' forms of interaction in order to identify every gesture, tone and verbal utterance within specific social situations. In particular, those who seem less interactive may need more structured and intense interaction than others (Tjus et al., 2001). This means that a subdued approach by the experimenter might have deprived some children of the very expressive interaction they needed the most, the 'quiet' children with ASD.

It is more likely that both interpretations have a place. The Son-rise program, for example, encourages parents and volunteers to challenge the child with autism when he is having a good day, and to be more accommodating to what he wants to do when he is having a bad day (Kaufman, 2004). In the same way, when first meeting a child with ASD, or if he is quiet or having a bad day, then it may be appropriate to start with a quiet communicative style, and only when the child is settled and comfortable with the presence of the adult, to introduce a more expressive mode of interaction. This is one more factor that could possibly be controlled during a session with a child with ASD. If similar studies to those reported here were to be carried out, then it is suggested that the experimenter should attempt to increase her levels of expressiveness throughout the session, if she feels that the child can cope with it.

9.4.2 Coding method

The coding method played a critical role in the analysis of the data, determining what would be observed, how it would be measured and the fineness of the measure. For example, it would have been possible to break down behaviours into subcategories, but at times this might not have produced any meaningful results. Also, the choice of behaviours to focus on, based initially on the coding experiences of previous research (Willis et al., in prep.) but modified here to fit with the different experimental context, could well have been different. Another potential limitation arises from restrictions imposed by the software used to analyse the videotapes (Noldus ObserverPro 5): for example two behaviours within the same category could not 'occur' simultaneously under its coding protocol, making it necessary to define behaviours more specifically and exclusively, a potential source of artefactual differences. Similarly, in cases when a child initiated a verbal interaction, the adult replied back and then the child replied, this had to be coded as one spontaneous and one responsive interaction. Such interactions were not frequent but they have to be considered when interpreting the results.

9.4.3 Subjects

One of the major concerns of the thesis was the limited number of subjects available for testing, a general problem in the field of research into autism. This does not allow very strong conclusions to be drawn. However, despite this limitation, the studies highlighted the significant variability in the interactive styles of the children as reflected in varying individual profiles of behaviours within and across different conditions of game playing. This is a reminder of the importance of always looking at the specific strengths and needs of each individual child with autism.

Regarding ethical aspects of the experimental conditions, the studies ensured that all children were equally exposed to all conditions. The fact that all conditions were designed to foster interaction also made sure that even if no significant interactive advance was made, at least the children with ASD would have been exposed to a positive social situation. In addition, the playful nature of the task made it enjoyable to all participants.

9.4.4 Game programming issues

Study 2 (Chapter 5) described how the children played against the computer. This obviously had to be programmed to allow automatic play. This involved coding the game strategy as described in Chapter 4 (see detail in Appendix F), but since this was fixed, the strategy could not be adapted should the need arise, as it could be when the game strategy was followed by the experimenter.

During the running of that experiment a problem arose: some children started to pick up the patterns of response built into the programme and stuck to one winning game plan, which, after a few games, led to them winning easily as each new puzzle was introduced. The researcher tried suggesting to these children that they place the first piece on another cell, to ensure their motivation through the randomness of the game, but they stuck with their own game plan, regardless of how easy it was. They realised that the computer 'was not very smart', but nevertheless seemed to enjoy the experience. This seems to contradict the principle that if a task is too easy it is not motivating. Most children remained engaged in the task and enjoyed the task, as demonstrated by the results of the video analysis (section 5.3), both in terms of the number of games they were willing to complete, and secondly by their personal, subjective accounts after the session (children were asked by the experimenter if they had enjoyed the session). Only one individual was obviously bored with the task, but even he continued to be engaged with the game until the trials were completed.

9.4.5 Compliance

The subjects in all of the studies reported in this thesis were all high functioning ASD children with no particular behavioural difficulties. It was not therefore surprising that they all agreed to participate in the experiments, despite displaying varying degrees of distraction during the course of the games played. Although this was positive in terms of being able to use all the data gathered and of all tasks being completed, it also meant that it was not possible to discriminate any motivational differences among the conditions on the basis of the child's engagement in the task.

9.4.6 Waiting time

The study presented in Chapter 7 included a competitive and a collaborative condition during which the child had to wait until the experimenter finished her game or move. This waiting time potentially allowed the child to become distracted and this often took place. An analysis of these conditions may be useful to understanding the process:

- In the competitive condition, children waited for at least 30 seconds, the time of the fastest game of the experimenter, and had to wait an average of 4 times. When there were fewer games it was because these took longer, making the waiting time longer as well.

- In the collaborative condition, waiting time was at most 10 seconds: a game lasted between 60-90 seconds on average (the fastest of all children took 25 seconds and the slowest 200 seconds). Taking 90 seconds as the mean time it took to place 9 pieces correctly, and assuming all pieces were placed correctly on the first attempt, the waiting time between turns was of the order of 10 seconds. In reality, most games involved several attempts at placement and therefore, more turn taking, but 10 seconds can be used as a reference point.

What this implies is that while a waiting time of around 10 seconds in the collaborative condition may not be enough time to become completely distracted, if the waiting time is greater than 30 seconds on average, as in the competitive condition, it may be more likely that distraction will occur.

In addition, every move of the partner in the collaborative condition affected the choices of the child: either because it was a piece correctly placed or because the error of the partner provided the child with additional knowledge on where not to place that piece. This alone could have been enough to keep the child engaged. The earlier Study 1, in which children played Noughts and Crosses against the experimenter, also suggested that they remained engaged in the game because the moves of the partner affected their options but also because there was minimal waiting time between their own moves.

9.4.6 Eye contact

Despite the optimal positioning of adult and child and the protocol design, all of the series of experiments demonstrated how difficult it was to make eye contact with children with ASD. To some extent, such interactions were constrained by the nature of the game. For example, where speed was required then there was pressure to respond quickly, albeit not as quickly as in a 'shoot'm'up' type of game where there has to be a reaction rather than a pre-meditated action. In the same way, the games used here all required a solution to a visual problem, thus making it necessary to look at the screen almost constantly in order to decide on the next step.

It is possible that a different type of game, such as a quiz or a strategy game (where the aim is to plan and develop a character or environment) would allow for more thinking time away from the screen and afford greater opportunities for eliciting more eye contact between players and greater discussion of strategy.

9.5 Implications of the research for classroom practice and interventions

9.5.1 Further uses for the games developed here

As described in the experiment protocols, the games used here were designed to develop interaction in children who typically find this social process very difficult. They could serve as 'ice breakers' to allow the children to get used to unfamiliar people or to work with peers in a friendly environment; they could be used to teach some children how to play, modelling how to ask for a turn, for help, how to lose and how to win gracefully, etc. They could also offer an opportunity for shared play and enjoyment, one which facilitates playing other versions of similar games away from the computer with the same partners, as was the case of a pair of children with ASD participating in Study 1, who later started playing Noughts and Crosses together on the classroom whiteboard on their own initiative, according to their teacher.

Teachers, parents and therapists could use the framework presented earlier to classify the games available to them in order to individualise their use for interaction purposes with specific children. In the same vein, game content could be individualised, with e.g. the jigsaw images changed to represent topics of interest to the child or to prompt discussions.

9.5.2 Using computers to foster social interaction

In the light of the experiences gained in determining the game processes and designing the game protocols and taking these in conjunction with the findings from each of the reported experiments, some principles for maximizing the opportunities for social interaction at the computer can be suggested. It is taken as a given here that there is a set of goals for the child within the social domain, and that the computer-based activities are organised around his daily routine.

- *Always work/play with a partner at the computer:* Whenever possible, make every activity at the computer a partnered one as this will create opportunities for turn taking, increase awareness of others, and foster discussion. When the partner is an adult, then it is possible to focus on modelling social skills, such as asking for help, or to use this relaxed environment to develop a relationship.

- *Social gaming*: Make sure that all the games installed or configured are two-player games, to ensure that any computer play time is also social. Where this is not possible, ensure that any one-player computer games are of a social nature (such as The Sims), so that even when playing alone there is some exposure to social rules.

- *Competition-collaboration*: There should be a balance between collaboration and competition in computer game-playing, as playing with both types of game will teach valuable skills. Within a collaborative game, it may be easier to help, ask for help, discuss ideas and learn to work as a team. Within a competitive game, a child can learn to cope with stress and the frustration of losing, as well as enjoying the challenge of playing against an opponent. Different games will make different demands on each of these aspects, and the ideal choice or balance will depend on the child with autism and his current stage in social development and degree of willingness to engage with another person.

- *Analyse available computer resources*: Spending some time looking at the games available and classifying them in terms of interaction and competitiveness (as in Tables 9.1 and 9.2) may help in choosing the most appropriate game for a specific child at any given time. Table 9.3 (below) shows a sample of some games chosen to represent a variety of game profiles. Although these games all belong to the simulation and sports categories, that is not to say that those types of games are the only appropriate ones. The specific games referred to in this section are simply examples, chosen because of the need to focus on real games in order to analyse them. There would be social value in many other types of games, if chosen carefully. The role of the partner is described as 'supportive' below when the game does not support multiple players and thus has to be played individually, which means that the partner can only watch. However, some single player games are more focused on decision making, a process that occurs outside the screen, rather than on the action taking place on-screen. In these, there is clearly more scope for collaboration while making those decisions, even although there is still only one player who interacts with the computer.

Table 9.3: A sample classification of some currently available computer games.

Game type	*Role of partner*	*Interaction*	*Competitiveness*
Simulation: The Sims	Supportive (Single player) Collaborator, if online version	Game about social world; Involuntary if online (characters interact)	Low
Simulation: Caesar, Sim City	Supportive/Collaborator (Single player)	Voluntary (if playing with a partner)	Low
Simulation: Civilization	Opponent	Involuntary: Partner's choices affect child's	Medium
Sports: e.g. FIFA Soccer	Opponent	Involuntary	High
Sports&racing: Nascar racing	Opponent	Voluntary	High

The Sims is a very unique game in which the player creates and controls the daily life of several characters, and as such involves a great deal of social knowledge. A partner can provide support, but it is an individual game. The online version allows for other players to join in, but every player can only control a single character. Because the characters interact with each other, their actions affect the child's play and hence the interactions are classified as involuntary.

Simulation games such as Caesar or Sim City are based on building a whole society with its buildings, economy and other everyday issues. These are only available for a single player at the moment, which means that playing with a partner means s/he will be acting as a supporter or collaborator and that any interaction taking place is voluntary, since the game does not require it. On the other hand, Civilization, another simulation game with similar features, allows multiple players, adding some level of competitiveness to the game and the involuntary interaction that the decisions of others cause.

Within the highly competitive sports games there are those that are clearly affected by the opponent's movements, such as a football game (e.g. FIFA Soccer), making the interaction involuntary. In a racing game (e.g. Nascar Racing), however, apart from a crash situation, what the opponent does does not affect the game of the child, thus, any interaction is essentially voluntary.

- *Positioning of the child and partner*: If possible, positioning the child and partner at a 90 degree angle, while still facing the screen, will facilitate access to the face, making eye contact easier. It may be necessary to allow sufficient time for the child to make eye contact, since the attraction of the screen seems to be very powerful, as well as using some verbal utterance to grab the child's attention.

- *Flexibility*: Taking into consideration the social learning goals for a child, both in the short and long term, it may at times be worth following the child's detour from the task at hand, even at the cost of not reaching the specific goals for that session. Although the task may not be completed, it may still be productive within the whole educational programme: the task and the computers are the means to create opportunities for interaction, and as such to be constantly reviewed and adapted to take into account the child's particular state of mind.

9.6 Further work

9.6.1 Naturalistic studies

It is a common criticism that research in autism is often carried out in artificial settings, and that findings may not transfer to many natural settings. This research has tried to test the use of computers by children with Autism in a variety of settings that resemble real life situations. The experimental setting replicated closely a real life setting: a desk with a computer in a classroom, as an experimental setting, and a real life task, such as playing a game, as the experimental task. To make it a 'real life setting' would have required the researcher to become involved in the daily life of the classroom under some role and the computer to be used as in the same setting is used normally, and the recording methods would not have been obvious to the children. Furthermore, the researcher might have taken the opportunities to interact even when it meant to deviate from the protocol. Nevertheless, the experimental task and guiding principles presented in the above section could still be integrated into classroom activity, relying on the teacher's sensitivity and reactiveness to the child's needs and interaction levels, completing the cycle from the classroom to research and back to the classroom.

Another aspect perhaps worthy of further observation is the potential of computers as a medium for relationship building. There are many anecdotal accounts of parents and teachers, and even from researchers, of computers being used to 'connect' with children with autism. Throughout the course of the experiments reported here, it was often felt that this medium really lent itself to discussion and conversations but that these could not be pursued without breaking the protocol. It would be very interesting to document any changes in these aspects of communication over a period of time in computer-mediated interactions, both in terms of the levels of interaction and its nature, especially in those children with autism who are the most withdrawn.

9.6.1 Formal research

In principle, it would be ideal if all studies were replicated to ensure that findings are reliable. In practice, in the social sciences, replication studies are few and far between. Should, however, any other researcher seek to replicate or indeed extend the studies reported here, then each has been presented in sufficient level to allow this. Having the applications and the associated very detailed scripts would allow the reported studies to be replicated in principal at least, and using the same video analysis coding system would test whether the findings are more broadly sound.

If a longer-term intervention were planned, the outcomes could be correlated with the results of the studies presented here and should any positive relationship between them be found, then the one-off game situations used here might have some potential role as a diagnostic tool.

A great deal of research is carried out which focuses only on the high functioning population within the autistic spectrum. In the case of the research presented here, the reason was to observe social skills without the additional confounding factor of co-existing learning disabilities. The next step would be to conduct similar investigations with the lower functioning end of the autistic child population, whether verbal or non verbally-based. This clearly would present new challenges with respect to game design.

There is a project that inspired this thesis, which could very easily be replicated with modern technology and which was explored briefly in the early stages of this thesis (see Chapter 3, p.77). Weir (1976) introduced a simple Turtle robot to an autistic child in 1976 and this yielded some very positive results, with the child becoming more socially engaged and displaying more verbal behaviour. This paradigm has not been explored further in the interim thirty years. Recent studies have focused more on the child playing with an autonomous robot (Dautenhan 1998, Werry et al. 2001), or on the interaction of two children and a robot (Robins et al., 2005). The main emphasis within Weir's experiment was on the child actually controlling the movements of the robot and thirty years ago, a research lab was needed to carry out the study. Today there are affordable robot building kits which are appropriate for children's use. The time is perhaps ripe to revive these studies, possibly designing a shared robot based game in which the role and proximity of the partner was more under the control of the child. For this thesis, however, it seemed important to first attempt to address some of the more fundamental questions.

9.7 Conclusion

The main finding of this thesis is that playing at the computer with a partner provides children with autism with a variety of opportunities for interaction, and that these opportunities are taken up. For some children, given a supportive infrastructure and careful partner management, the computer may be the medium within which they display the highest levels of social interaction. It is a tool to be considered more carefully when planning classroom or home-based computer activities aimed at fostering social interaction.

It is also important to note that, at least while playing at the computer, children with ASD are not that different from typically developing children. Considering the positive social status given to children who understand technology and given that being at the computer to some degree minimizes the social awkwardness normally displayed by a child with ASD, computer-based play and learning create possibly unique opportunities to develop social relationships with a peer group.

On the basis of the findings presented in this thesis, it is suggested that the use of computers as described here have the potential to have a direct impact on the development of social skills in children with ASD. They may also have a lifelong effect in that they may underpin the formation of friendships, allowing these to grow in a positive affirmative environment. At the very least, even if no lasting benefits occur as a consequence of play with partners at the computer, the child will have enjoyed an activity, a social one, one that might otherwise elude him.

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Appendix A

Negotiation Tutor

Given an opportunity to explore the use of Intelligent Tutoring Systems to teach social skills to children with ASD during a summer school on the topic the specific skill selected was negotiating the game to be played between two partners (Wu and Pino, 2001).

Methods.

The Summer School took place at the Center for Intersdisciplinary Research on Constructive Learning Environments at Carnegie Mellon University (US) for a week involving tutorials and supervised development of the project. The team members were Amy Wu, who focused on TDK programming and Begona Pino, who took responsibility for designing the functionality and layout of the tutor according to profile of the users, with Jill Fain Lehman, expert both in Tutoring systems and Autism, as supervisor. Early ideas were discussed prior the Summer School by means of email, deciding on the final project design considering the time constraints and the target population. The prototype was implemented using the Tutor Development Kit created by the research team based on LISP, an artificial intelligence language.

Design

The Tutoring System had to provide a context in which two people, a child with ASD and a socially skilful partner, could decide on what game to play together. It was thought that playing games was a motivating task and learning to take turns at choosing favourite games was a skill that could enhance the social life of the children with ASD. The system should be installed as a gateway to access the computer games in the machine the child uses. In order to design the tutor, the skills involved needed to be analysed and broken down into programmable steps. The interface would maximise the use of visual information, to build on the visuospatial skills of children with ASD, and it would have little verbal language and distractions, to minimise the effect of impairments in language and shifting of attention these children tend to have, following Quill (1997) rationale for visually cued instruction.

Negotiation situations involve different levels of skill. The most basic just requires an expression of what each party wants, and if this is the same, they can agree on it. However, when trying to convince a person of doing something he or she is not really interested in, it is necessary to find some other benefit which may motivate him/her. This requires to know what this person may like or want and offer it to make the proposal more appealing or in exchange of what it is wanted of him (e.g.: "play my game").

> *Example*: Child wants to play Game 1, and Partner doesn't want to play. Child knows Partner likes basketball, so he informs Partner that it is a basketball game. He can insist with another argument if knowing that Partner likes cool music, and the Game 1 ALSO has good music.

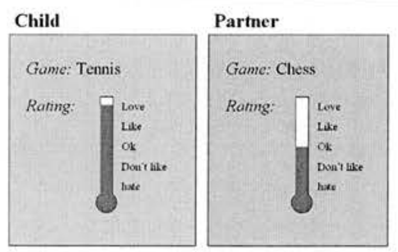
The previous examples are based on the matching of games characteristics (descriptors) and the Partner interests, in order to make the Child's choice more appealing to the Partner. At a deeper level, the child may offer something outside the game framework such as "I'll give you my lunch", "I'll do your homework", or even "I'll be your friend", which is a very sophisticated social reward.

Tutoring:

The system can be used to model good techniques if the Partner takes initiative, or it can be used as a context for the child to explore, with the Partner being more or less collaborative. The prototype designed was based on the second option.

To start, the system would provide a list of games for each player to choose from. If that game is the same, they can go on and play it, however, if it is different then negotiation process starts. Then each player rates his own game and his partner's, using a visual rating scale as in Figure A.1, followed by the Child being asked if he would play his Partner's game, and vice versa. If they have not agreed yet, then the systems provides an opportunity for the Child to present arguments to make his game more appealing to the Partner, after which, the process starts again with a new set of games until they agree on one or there are not more games,

Figure A.1: Rating scale



Algorithm:

- Step 1: each player pick a game; if it is the same, they play it (if not, step 2)
- Step 2: each player rates their chosen game
- Step 3: each player rates their partner's chosen game
- Step 4: players may re-rate their chosen games
- Step 5: *Basic Negotiation*: Child asked if he would play Partner's chosen game; if not, Partner's asked if he would play Child's game (if not, step 5)
- Step 6: *Advanced Negotiation*: Child suggests features that make game more appealing considering the Partner's interests, or offers something else he may like, a limited number of times, after which, they go back to step one and try with another set of games. Alternatively, the system may control the game choice by doing one of the following:
  - System offers to play each of the games half of the time.
  - System offers to play a random game (none of the chosen ones).
  - System does not let them play until they agree on one game.

Discussion

The system challenged the child with ASD in a range of ways. First of all, it required decision making skills to decide on one game to play, then the child need to recognise and externalise his feelings in order to rate a game, as well as recognise the feelings of others. Being exposed visually to the different levels at which both parties would want to play their chosen game provides an insight in the mind of the other and the opportunity to change a choice as well as to take into consideration whether the partner likes his game more than the child with ASD likes his. Finally, the system would mediate the child's attempts to persuade the Partner into playing his chosen game. Table A.1 shows the correspondence between the required skills and the steps followed by the Tutoring System:

Table A.1: Correspondence between skills required and steps followed.

Skills	Steps
1. Decision making	1. Choose a game
2. Recognising own feelings	2. Rate the game
3. Recognising other's feelings	3. Look at other's rating
4. Be able to change opinion	4. Re-rate both games
5. Give priority to other's choice	5. Accept the other's game
6. Be able to offer something in exchange for getting what they want	6. Or... offer something else in exchange for playing your game (trade)

All these means that some children may not have the basic skills needed to cope with the system, since they may feel stressed about making an initial choice. For the same reason, some children may accept someone else's choices just to avoid discussing about it, whereas some other may find it difficult to change his own choice altogether. The system would still be useful for these children if an adult (parent, teacher, etc.) is present to support the child in whatever aspects he finds more challenging.

Although the skills supported by this Negotiation Tutor were considered very valuable, the sophisticated technical environment and the knowledge base where the prototype was developed were not going to be available for the development and evaluation a complete application, reason why this line of research was not pursued in this thesis.

On the other hand, the development of the prototype required an analysis of the process and a decomposition into small tasks that can be followed with a paper version of the rating scale with a human tutor controlling the access to the games. In this case, the requirements of a computer system have originated a series of rules that can be taught outside the computer context.

Appendix B

Questionnaire on Computers and Autism

Questionnaire on Computers and Autism

This questionnaire is oriented to teachers and other professionals involved with people with Special Educational Needs, in particular with Autistic Spectrum Disorders (ASD). The purpose is to gather your opinion about the possibilities of computers to aid/enhance communication and social interaction skills in people with ASD. The term ASD is considered to include autism, Aspergers Syndrome and autistic features diagnosis.

Occupation: ________________________

Degree/Professional Qualification/s: ____

Date of Birth: __________ Male ☐ Female ☐ (please, tick as appropriate)

1. Do you have experience with people with ASD?

	Adult	Child
Yes	☐	☐
No	☐	☐

If NO, please go to question 2.
If YES, is this experience personal or professional?

Personal ☐ professional ☐ both ☐

what type of diagnosis did they have (please, state the number of cases you have had contact with of each category that applies)

	Number of Cases
Autism with learning difficulties	
Autism (no language)	
Autism (language)	
Aspergers Syndrome	
Autistic features	
Other (please specify): __________	

How long has been the duration of your experience for ?
(i.e. months, years): ____________________

2. Do you have access to computers?

Yes ☐
No ☐

If NO, please go to question 9

If YES, Where do you have access? (please, tick all that apply, specifying the type of computer)

	PC	Mac	Other
Home	❑	❑	❑
Friend, relative	❑	❑	❑
Work place, shared	❑	❑	❑
Work place, own computer	❑	❑	❑
Public access (i.e.libraries)	❑	❑	❑
Other (please specify) :______________	❑	❑	❑

3. Do you use computers?

Yes ❑
No ❑

If NO, why not? (please, tick all that apply)

I don't like them ❑
I don't need to ❑
I don't know how ❑
Other (please specify): __________________ ❑

Would you like to use them?

Yes ❑
No ❑

please go to question 9

If YES, how frequently do you use them in each of these settings?

	Never	Rarely	Monthly	Weekly
Home	❑	❑	❑	❑
Friend, relative	❑	❑	❑	❑
Work place, shared	❑	❑	❑	❑
Work place, own computer	❑	❑	❑	❑
Public access (i.e.libraries)	❑	❑	❑	❑
Other (please specify) :______________	❑	❑	❑	❑

How long is the average session? (i.e. minutes, hours)__________________

4. What do you use computers for? (please, tick all that apply)

Word processing	☐	Educational software	☐	Programming	☐
Internet browsing	☐	Games	☐	Authoring software	☐
Email	☐	Presentation software	☐	Internet chat	☐
Spreadsheets	☐	Graphic design	☐	Internet shopping	☐
Databases	☐	Professional applications (statistics, etc…)	☐	Other (please specify) ____________	☐

5. Do you like using computers? (please, tick only one)

Dislike very much ☐ Dislike ☐ Not bothered ☐ Like ☐ Like very much ☐

6. Do you find them useful? (please, tick only one)

Never ☐ Rarely ☐ Sometimes ☐ Frequently ☐ Always ☐

7. Do you use computers for non-work related activities? (please, tick only one)

Never ☐ Rarely ☐ Sometimes ☐ Frequently ☐ Always ☐

8. If you just use computers at work, would you use them if you didn't have to? (please, tick only one)

Never ☐ Rarely ☐ Sometimes ☐ Frequently ☐ Always ☐

Questions 9- 15 are intended only for teachers or people who are working in a school setting. Others, please go to question 16

9. What type of school do work at? (please, tick all that apply)

Primary ☐ Secondary ☐ Special ☐
Public ☐ Private ☐ Subsidised ☐

10. Approximately, how many students attend the school?____________

11. Approximately, how many computers are there accessible to students and where are these?

	Number of Computers
Computer lab	
Classrooms	
Library	
Sciences Labs	
Other (please specify):___________	

12. What sort of access do students have?

Only during a class ☐ Only for coursework ☐ Free access ☐

13. What do you yourself use computers mainly for? (eg, Preparing course material, consulting resources on the internet.)

____

14. What do students at your school use computers mainly for? (eg. Checking email, searching material for coursework)

____

15. What do your own students use computers mainly for?

____

16. Which of the following types of technical or computer based devices or activities do you think might be of benefit for people with ASD and which might be detrimental?

	Very detrimental	Detrimental	Non detrimental Non beneficial	Beneficial	Very beneficial
Word processing	☐	☐	☐	☐	☐
Speech recognition	☐	☐	☐	☐	☐
Pointing devices	☐	☐	☐	☐	☐
Communication	☐	☐	☐	☐	☐
Software	☐	☐	☐	☐	☐
Educational software	☐	☐	☐	☐	☐
Computer games	☐	☐	☐	☐	☐
Robotic toys	☐	☐	☐	☐	☐
Electronic toys	☐	☐	☐	☐	☐
Internet browsing	☐	☐	☐	☐	☐
Graphic design software	☐	☐	☐	☐	☐
Programming					

17. Have you personally use any of the above technical or computer based devices or any other such device with people with ASD?

Yes ☐

No ☐

If NO, why not? (please, tick all that apply)

I don't have access ❑
It is not related to my job ❑
I don't know how to ❑
Other (please specify) :_________________ ❑

Would you like to use some of them?

Yes ❑
No ❑

please go to question 18

If YES, Did you find them useful?

	Never	Rarely	Sometimes	Frequently	Always
Word processing	❑	❑	❑	❑	❑
Speech recognition	❑	❑	❑	❑	❑
Pointing devices	❑	❑	❑	❑	❑
Communication	❑	❑	❑	❑	❑
Software	❑	❑	❑	❑	❑
Educational software	❑	❑	❑	❑	❑
Computer games	❑	❑	❑	❑	❑
Robotic toys	❑	❑	❑	❑	❑
Electronic toys	❑	❑	❑	❑	❑
Internet browsing	❑	❑	❑	❑	❑
Graphic design software	❑	❑	❑	❑	❑
Programming					

18. Do you think that people with ASD should use computers?

Yes ❑
No ❑

If YES, (please, tick only one)

Only under supervision ❑
Only on their own ❑
Both supervised and on their own ❑

What do you think might be of benefit on using computers with people with ASD?

19. What do you think might be the potential risks of using computers with people with ASD?

20. How would you address these potential risks?

22. If you have any related thought or suggestions, we will welcome them here:

Thank you very much for your cooperation

Appendix C

IT and autism: practitioner interview structure

Personal data
- Qualifications
- Background (previous experience with autism)
- Time in the centre, in the post

Resources in the centre
- Number and type of computers
- Individual/computer ratio
- General use of the computers

What do you do?
- Specific activities/software
- How?
- Frequency, time...

Why do you use computers?
- own initiative, somebody, read about it...

Does it work?
- In what aspects (your goals)
- With whom, under what circumstances
- After how long time?
- Benefits and risks

Adults (numbers)
- In the centre
- With autism
- You work with (diagnosis, age, difficulties)

What would you need/like regarding computers?
- Training: in what
- Research in some topics
- Assistants or less individuals/therapist ratio?
- More computers?
- Any other?

Appendix D

Letter to Head Teacher

Project: Social Interaction in computer-based activities

Graduate School of Education
Simon Laurie House
Moray House School of Education
University of Edinburgh
Holyrood Road
EH8 8AQ Edinburgh

Information for Head Teachers

Dear Sr./Mrs.,

I am a PhD student doing research in the field of Autism and Computers. I would like to carry out an experiment to observe the characteristics of the interaction between a child with autism and an adult (myself) when collaborating in a computer mediated activity.

I would really appreciate your help in finding suitable participants. I am mainly seeking children between 6-16 years old, with a diagnosis of autism but not learning difficulties. Basically I would need children who have difficulties in communication and social interaction but are more or less ready to become involved in an activity (playing a game) that may not be their preferred one (not their favourite game).

The participants will have two one-off session of 10-15 minutes of interaction that will be recorded for posterior analysis. The purpose of this study is to observe differences and similarities when doing the same activity in a manual media (board game) or in a computer.

After this initial study, some participants may be invited to participate in a second study which will involve a 6-10 sessions with an adult (again myself) where individual preferences of activity will be taken into account. The aim of this study is to gain an in depth understanding of these interactions, attending to the individual interests.

All the material regarding this research will be treated confidentially and anonymity will be respected in any publication or document derived from it. Authorities and parents will be asked for permission.

If you need any further information, please, do not hesitate to ask.
I am looking forward to hearing from you.

Begoña Pino

Phone: 0131-651 6459
E-mail: Begona_Pino@education.ed.ac.uk

Appendix E

Letter and parental consent form

Project: Social Interaction in computer-based activities

Graduate School of Education
Simon Laurie House
Moray House School of Education
University of Edinburgh
Holyrood Road
EH8 8AQ Edinburgh

Information for parents

This research intends to investigate the use of computers as an environment to teach and practice social understanding with children with autism or Asperger's Syndrome. A computer-based activity provides a 'real life' environment, and a shared interest, as well as serving as a motivational and safe tool around which to construct a relationship.

In the first stage of the research, the goal is to observe the characteristics of the interaction between a child and an adult when collaborating in a computer-mediated activity. In particular, it is intended to find out whether the computer fosters greater social engagement: whether the child is involved in more and longer interactions, initiates more interactions, increases eye contact, etc. The child and researcher will carry out an activity (playing a game) in both a computer and non-computer version during two one-off sessions of 10-15 minutes.

The second stage will aim to improve children's social understanding by putting social rules into practice using child-adult computer-mediated activities over a longer period. A smaller subset of the initial group of children will take part. The activity will be tailored to the child's interests, with the adult playing more the role of assistant rather than teacher. This will run over 6-8 weeks approximately, and involve sessions of 20-30 minutes per week.

The research will take place in school over the next few months and the timing of the sessions will be decided in consultation with the class teacher to minimise any disruption for the children and the class. Some sessions will be recorded in video for more detailed analysis. All the data from the research will be treated as confidential and participant anonymity will be respected in any publication or document derived from it.

I hope all the activities will be fun for everybody.

If you would like any further information please contact:

Begoña Pino

Phone: 0131-651 6459
E-mail: Begona_Pino@education.ed.ac.uk

Project: Social Interaction in computer-based activities

Graduate School of Education
Simon Laurie House
Moray House School of Education
University of Edinburgh
Holyrood Road
EH8 8AQ Edinburgh

Dear

I am a postgraduate research student carrying out a project to find out how to use computers to improve social interaction skills in children and young people with autism or Asperger's Syndrome.

I would be very grateful if you would allow your son/daughter to be involved. I would meet with each participant for 10-30 minutes during the school day, two times for the first part of the project and 6-8 times for the second part.

I enclose a brief description of the research but if you would like any more information, please do not hesitate to phone me on 0131- 651 6459.

Thank you very much for your help

Yours sincerely

Begoña Pino
Research Student

Project: Social Interaction in computer-based activities

Graduate School of Education
Simon Laurie House
Moray House School of Education
University of Edinburgh
Holyrood Road
EH8 8AQ Edinburgh

Consent form for researcher

I have read and understood the information sheet provided by Ms. Pino ☐

I have been given the opportunity to contact Ms. Pino for further information, if required. ☐

I am happy for my son/daughter to take part in the research described ☐

OR

I would prefer my son/daughter **not** to take part in the research described ☐

Name (parent / guardian):

Child's name:

Signed Date

Please return in self addressed envelope to the Head Teacher or to Begoña Pino at the above address.

Project: Social Interaction in computer-based activities

Graduate School of Education
Simon Laurie House
Moray House School of Education
University of Edinburgh
Holyrood Road
EH8 8AQ Edinburgh

Consent form copy for parent / guardian

I have read and understood the information sheet provided by Ms. Pino ☐

I have been given the opportunity to contact Ms. Pino for further information, if required. ☐

I am happy for my son/daughter to take part in the research described ☐

OR

I would prefer my son/daughter **not** to take part in the research described ☐

Name (parent / guardian):
Child's name:

Signed Date

Appendix F

Noughts and Crosses playing strategies

0	1	2
3	4	5
6	7	8

1. the central cell (number 4) offers four possible lines: 147, 345, 048, 246
2. any corner cell (0, 2, 6 or 8) offer 3 possible lines: e.g. 012, 048, 036
3. any other cell (1, 3, 5 or 7) offer 2 possible lines: e.g. 1 - 012, 147

To win

Move 1:

take cell in the centre (4)

Move 2:

take any free corner cell (0,2,6 or 8), provided its diagonal opposite corner cell is free, e.g. 0

Move 3:

(a) take the opposite corner if available, e.g. 8, line 048 END

(b) or take any other corner (e.g. 2); 2 possible lines in the next move

Move 4,5:

(a) take a cell that will complete a line: eg. 6 (246) or 1 (012)

The need to neutralise opponents attempts to make a line will guide the choice of cells according to this strategy.

Not to lose

Move 1:

(a) random move or

(b) move to win

Move 2:

if player1 got two cell in line, take the third that would complete the line

Move 3, 4:

like move 2

To lose

Move 1:

avoid central and corner cells (pick any of 1, 3, 5, 7), eg. 1

Move 2:

avoid putting 2 in line;

Move 3, 4, 5:

avoid making lines

Appendix G

Experimenter Interaction Protocol

<u>Session:</u>

(Game is on table, ready to play with)

1. greeting
2. invitation to sit down (experimenter at left, student at right, chairs separated by 20 cm.)
3. invitation to play ["Lets play".]
4. ask "Do you know how to play 'Noughts and Crosses'?"
    a. if YES then START playing (see below)
    b. if NO then EXPLAIN rules, then START playing (see below)
5. when time is up, session is finished
    a. "time is up, we have finished", looking at child (smiling)
    b. close game window (computer version)/close booklet (paper version)
6. ask child "Did you enjoy it?"
7. "Thanks for playing, good bye."

START playing

a. Tell child "You start the first game"
b. Tell child "We'll play a match at the best of 15 games"
c. "Your turn"

GAME:

1. child/player 1 moves
2. adult/player 2:
    a. "It's my turn now" (looking at child)
    b. take mouse/pen
    c. move according to GAME strategy (win, not to lose, lose)
    d. hand over mouse
    e. "It's your turn" (looking at child)
3. repeat 1 and 2 until FINISH (there is a line or the board is full)
4. FINISH
    a. Say "Player X wins" or "Tie" according to result
    b. count up the current number of the win or tie (automatic in computer version, by hand in paper version)
    c. if 15 games already played, then END OF MATCH
    d. otherwise, start new game:
        i. set up new board (clear button, or new sheet)
        ii. player 2 (adult) makes first move (alternating over is trials)

All verbal exchanges to be accompanied by adult looking at child.

<u>EXPLAIN rules:</u>

Goal: to put three matching symbols (O or X) in a line
Rules:

1. "You will be player 1 and I'll be player 2"
2. "You will write O's and I'll write X's"
3. "You can only write in empty cells"
4. "The game goes on until there one of us makes a line or there are no more empty cells"
5. "We will take turns to start a game"
6. "We will play a match of 15 games"

SESSION strategy:

- If there is time to play 2 matches or more, adult will lose the first and will try to win the second (probably will not finish).
- Keep an overall balance in favour of child.
- Keep a similar speed of response to the child.
- Maximize his/her engagement by modifying the playing strategy

MATCH strategy:

Assuming matches of 15 games.

1. play TO LOSE the first 3 games
2. then use these strategies in sequence (and repeat the sequence)
    a. if starting game: play to win in the second move; if second player: play to win in first move
    b. Play to tie
    c. Play to win
    d. Play to lose.

Set up

Computer version

- laptop
- mouse (shared)
- computer on top of a table, players side by side in front of screen

Paper version

- paper booklet
- pen (shared)
- board on top of a table, players side by side with board in between

Experimenter always sits on the left, child on the right

Verbal protocol:

In order to control researcher verbal interaction across sessions, the following 'scripts' were used:

1. If child has taken too long to decide:
    a. "Yeah, it was difficult to decide"
    b. "That was a hard one"
    c. "Nice one"
2. If child stops adult making a line:
    a. "Good move"
    b. "That was clever"
    c. "Smart"
3. If child makes a line:
    a. "Great, you've got it"
    b. "Well done"
    c. "Cool"
4. If child is winning
    a. "You are a tough player"
    b. "You know what you are doing"
    c. "You are very good at this"

When used in the match (see Table G.1), the above scripted comments were spread over the 15 games but used more frequently in the first few games, at least one time on the first 4-5 games, and then at least every third or fourth game thereafter (as the child's playing speed increased).

Table G.1 MATCH PLAYING SCRIPT

Player	GAME	STRATEGY	RESEARCHER BEHAVIOUR
Child	1	play TO LOSE	1,2,3 (praise and encouragement)
Adult	2	play TO LOSE	1,2,3 (praise and encouragement)
Child	3	play TO LOSE	1,2,3 (praise and encouragement)
Adult	4	Play to WIN at second	1,2,3 (praise and encouragement)
Child	5	Play to TIE	1,2,3,4 (you are winning) (praise or encouragement)
Adult	6	Play to WIN	
Child	7	play TO LOSE	
Adult	8	Play to WIN at second move	1,2,3 (praise and encouragement)
Child	9	Play to TIE	
Adult	10	Play to WIN	
Child	11	play TO LOSE	1,2,3,4 (you are winning) (praise and encouragement)
Adult	12	Play to WIN at second*	
Child	13	Play to TIE	
Adult	14	Play to WIN*	
Child	15	play TO LOSE	1,2,3,4 (you have won) (praise and encouragement)

*Strategy modified to maximise child's engagement in the game, depending on success. Game 12 and 14 may therefore be played to TIE or to LOSE.

Trouble shooting

Child does not want to play

- experimenter asks again in a more polite form:
  "Please, play with me, I really like this game, and you will too, let's give it a try"
- if still negative, insist one last time:
  "I think you would like it. Would you mind playing at least a few games? If you then don't want to play anymore we will stop. What do you say?"
- if still negative, thank him for his time, accompanying him back to classroom, and say goodbye
  "Maybe we'll do it another day"

Child goes off task

- remind him it is his turn "Your turn"
- if still off task, call his name and tell him it is his turn "X, it is your turn now"

Child shows frustration after losing a game

- experimenter may say "Never mind, you may win the next one"
- ignore behaviour; carry on playing (according to level of frustration and characteristics of individual child)

Child plays but doesn't seem to understand (e.g. ignores they an opportunity to complete a line)

- do nothing, (the important thing is that the child is engaged). Able children may be checking whether adult is letting them win; randomness of playing protocol avoids this being confirmed).

Child does not want to give up pen/mouse

- "It's my turn"
- "I need the pen/mouse"
- "You have to give me the pen/mouse, you'll get it back"

Appendix H

Video analysis: Behaviours and modifiers

<u>Subjects</u>
Child
Adult

<u>Behaviours</u>

<u>Verbal communication</u>
- On task speech
- Off task speech
- Inaudible/incomplete
- Quiet

<u>Non verbal communication</u>
- On task nvc
- Off task nvc
- No nvc

<u>On/Off task</u>
- On task behaviour
- Off task behaviour

<u>Modifiers</u>

On speech
- Offer prompt
- Direct Offer
- Ask help
- General topic
- General query
- Game query
- Encouragement
- Turn
- Results
- Celebrate self
- Celebrate partner
- Help hint
- Help solution
- Accept help
- Reject help
- Prompted help

Initiation
- Spontaneous
- Response

On nvc

Look (at partner)
Point (at screen)
Celebration
Attention

Off nvc

Away (look away from screen)
Off camera
Off seat (away from seat)